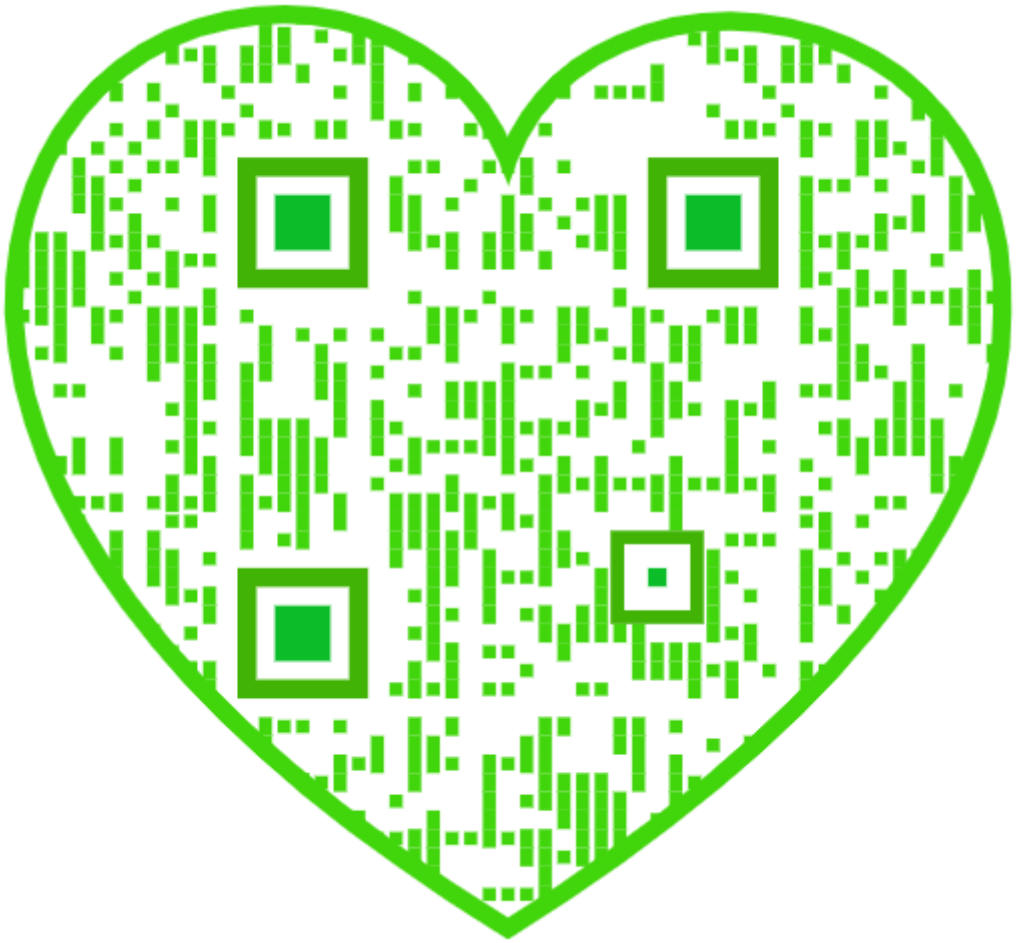

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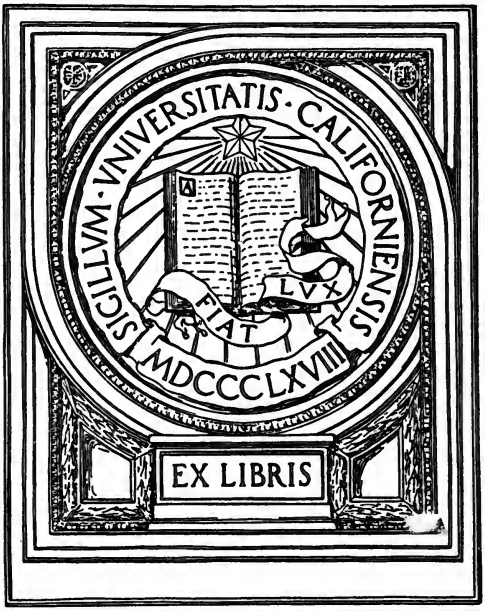

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DEMONSTRATIONS OF ANATOMY.

ELLIS GEORGE VINER

ELLIS'S DEMONSTRATIONS

OF

ANATOMY

BEING A

GUIDE TO THE KNOWLEDGE OF THE HUMAN BODY

BY

DISSECTION

Twelfth Edition

REVISED AND EDITED BY

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PREFACE.

In preparing this edition of Ellis's "Demonstrations of Anatomy," it has been my first care to preserve those features for which the book has been so justly valued in the past, and not to interfere with its general style and character.

The advances in the knowledge of anatomy during recent years and the present order of teaching have, however, necessitated many changes.

The matter has been altogether re-arranged, and it now follows the ordinary course of dissection as taken by students, beginning with the simpler anatomy of the upper and lower limbs and ending with the more complex parts of the head and neck and the organs contained therein.

In some places old matter has been taken away, and in many parts new work has been brought in, especially in those dealing with the different viscera. In this connection I wish to acknowledge the debt I owe to the works, amongst others, of Birmingham, Cunningham, Symington, Keith, Dixon, Elliot Smith, Berry, Jonnesco, Young and Robinson.

Sixty-two illustrations have been added, twenty-seven of them in colours, and amongst the subjects of these latter are those of many of the bones showing the attachments of the muscles. Forty-eight old illustrations have been reproduced in colour, and several of the blocks have been retouched.

Mr. T. P. Collings has devoted much care to the execution of this part of the work.

I am grateful to the publishers for the ready manner in which they met my requests; and my sincere thanks are due to Mr. W. S. Fenwick, B.Sc., for his help in preparing rough drawings of some of the new illustrations, in reading proofs, and for many good suggestions. He also, with Mr. A. E. Ironside, has carried through the work on the Index.

CHRISTOPHER ADDISON.

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Dr. Frank D. Walsh

DEMONSTRATIONS OF ANATOMY.

DISSECTION OF THE UPPER LIMB.

CHAPTER I.

DISSECTION OF THE BACK.

General Directions. The student begins his work in practical anatomy by the dissection either of the upper or of the lower limb. During the first three days that the subject is in the dissecting-room it is placed in the lithotomy position for the dissection of the perineum by the workers on the abdomen. On the fourth day the student begins the dissection of the back or of the buttock, according as to whether he has been allotted an upper or a lower limb.

How to remove the skin.

In removal of the skin the edge of the knife should be kept directed towards it so as to remove the skin, and no more. The underlying tissue, consisting of the *superficial fascia* and containing the cutaneous nerves and bloodvessels and a variable amount of fat, is to be left behind. Therein the operations of dissection are the reverse of those of surgery, for the surgeon, in making a flap, is careful to remove a considerable amount of the subjacent tissues along with the skin so as to preserve its blood and nerve supply.

Time for dissection.

Dissection of the Back. The dissection of the back is undertaken conjointly by the dissectors of the head and of the upper limbs, the former preparing the neck, the latter making ready the dorsal and lumbar regions. Two days are allowed to the dissector of the upper limb; in which time he will examine the first two layers of the muscles of the back and the associated vessels and nerves.

Position of the Body. The body lies with the face downwards. The trunk is raised by blocks placed beneath the chest and the pelvis, so that the limbs hang over the end and sides of the

dissecting table. The head is to be depressed and fastened with hooks so as to make tense the neck.

Surface Anatomy. Before commencing the dissection of any part the student should examine the surface of the body so as to define the bony and other landmarks by which the surgeon or physician is guided in his practice. At the upper part of the neck, posteriorly, in the middle line will be felt the *external protuberance* of the *occipital* bone, and running outwards from this will be found the superior curved line of the same bone. Passing downwards and outwards from this to the upper part of the shoulder is a ridge produced by the outer border of the *trapezius* muscle.

At the lower part of the neck in the middle line the prominent spine of the seventh cervical vertebra is readily found, and the *spines* of the one or two succeeding dorsal vertebræ. Below this the spines of the vertebræ can be felt as the fingers are passed down the furrow in the middle of the back, but the spines are much obscured by the strong ligaments which pass over and between them. The furrow is produced by the strong *erector spinæ muscles* which run longitudinally on either side. At the lower end of the back the series of spines can be traced on to the sacrum, at the lower part of which they disappear, and the coccyx is then felt bending forwards at the bottom of the furrow between the two sides of the buttock. At the side of the back the *crest of the ilium* runs outwards on either side, its highest part being on the same level as the spine of the fourth lumbar vertebra and its posterior superior spine lying at the bottom of a little depression opposite the second sacral spine. The lower four or five *ribs* can be felt below the scapula, and it is to be remembered that the twelfth rib is often short, and its tip can, in those cases, only be made out by deep pressure at the outer border of the erector spinæ muscle, two inches or so above the iliac crest. The upper angle, the vertebral border, the lower angle, the spine, and acromion process of the *scapula*, and the outer part of the *clavicle* should next be made out, and the matter will be made easier if the limb be moved about during the examination. When the limb is placed down beside the body the upper angle of the scapula is opposite the second intercostal space, the root of the spine is on a level with the spine of the third dorsal vertebra, and the lower angle is usually over the seventh intercostal space. Finally, running upwards to the upper limb from the side of the body is the fold produced by the *latissimus dorsi* muscle, which forms the posterior boundary of the armpit, or axilla.

Dissection. The first step is to raise the skin in two flaps by means of the following incisions : (1) from the spine of the seventh cervical vertebra along the middle line to the lower end of the sacrum (fig. 1, A, B and C) ; (2) transversely outwards from the spine of the seventh cervical vertebra to the outer border of the acromion (fig. 1, A—E) ; (3) upwards and outwards from the last dorsal spine along the posterior fold of the axilla to the upper limb (fig. 1, A—F) ; (4) outwards from the lower end of the median incision two-thirds of the way along the iliac crest (fig. 1, A—G). The two flaps of

skin, one below and the other above incision F, are to be turned outwards.

A great part of the trapezius muscle will be found under the upper flap, and of the latissimus dorsi under the lower flap.

The reflection of the skin from over the upper part of the trapezius is performed by the dissector of the head and neck.

The cutaneous nerves should first be sought for in the superficial fatty layer. They are accompanied by small arteries which will guide the student to their position. The nerves vary much in size

Cutaneous nerves:

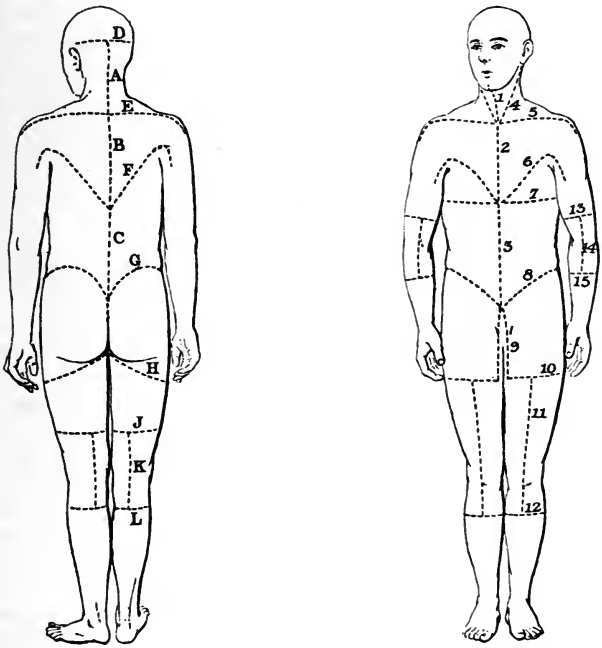


FIG. 1.—PLAN OF THE CHIEF SKIN INCISIONS.

in the different parts of the back, and their number is also irregular; as a general rule, there is one opposite each vertebra except in the neck.

Over the upper part of the thorax, they will be found near the spines of the vertebræ, where they lie at first beneath the fat; but at the lower part, and in the loins, they issue in a line with the angles of the ribs.

CUTANEOUS NERVES. The tegumentary nerves are derived from the posterior primary divisions of the spinal nerves, which divide amongst the deep muscles into two branches, inner and outer. Arteries accompany the greater number of the nerves, bifurcate like them, and furnish cutaneous offsets.

how derived.

The student is now concerned with branches of the dorsal and lumbar nerves. See fig. 2.

In the dorsal region.

Dorsal nerves (D. 1—12). These are furnished by both the inner and outer branches—the upper six or seven from the inner, and the lower five or six from the outer. On the surface they are directed outwards in the integument over the trapezius and latissimus dorsi muscles. The *upper nerves* perforate the trapezius near the spines of the vertebræ; and the branch of the second, which is larger than the rest, extends outwards over the scapula. The *lower nerves* pierce the latissimus dorsi mostly in a line with the angles of the ribs; the number of the superficial offsets from these nerves often varies.

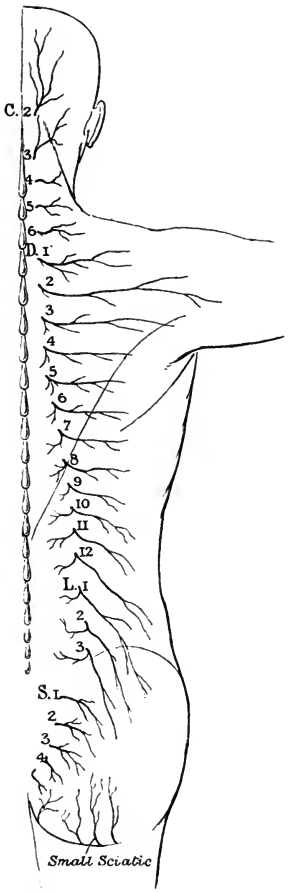


Fig. 2.—Cutaneous Nerves of the Back.

In the loins.

Lumbar nerves (L. 1—3). In the loins the nerves are derived from the outer branches of the first three lumbar nerve trunks; they perforate the latissimus dorsi muscle at the outer border of the erector spinæ, and crossing the iliac crest of the hip-bone, are distributed in the integuments of the buttock.

First Layer of Muscles (fig. 3). Two muscles, the trapezius and the latissimus dorsi, are included in this layer, and are now to be cleaned.

Dissection.

Dissection. The superficial fatty layer and the unimportant deep fascia are to be removed together from the trapezius and latissimus dorsi in the direction of the fibres of each, viz., from the shoulder to the spinal column; and the upper limb is to be carried backwards or forwards according as it may be necessary to put the different portions of the muscles on the stretch.

Some of the cutaneous nerves and vessels may be left in order that they may be afterwards traced through the muscles to their origin.

Trapezius: origin;

The trapezius muscle (fig. 3, A) is triangular in shape, with the base towards the spine, but the two muscles together have a trapezoid form. The muscle has an extensive *origin*, by short

tendinous fibres, from the spines of all the dorsal and of the seventh cervical vertebræ, and their supraspinous ligaments, from the ligamentum nuchæ, and from the inner third of the superior curved

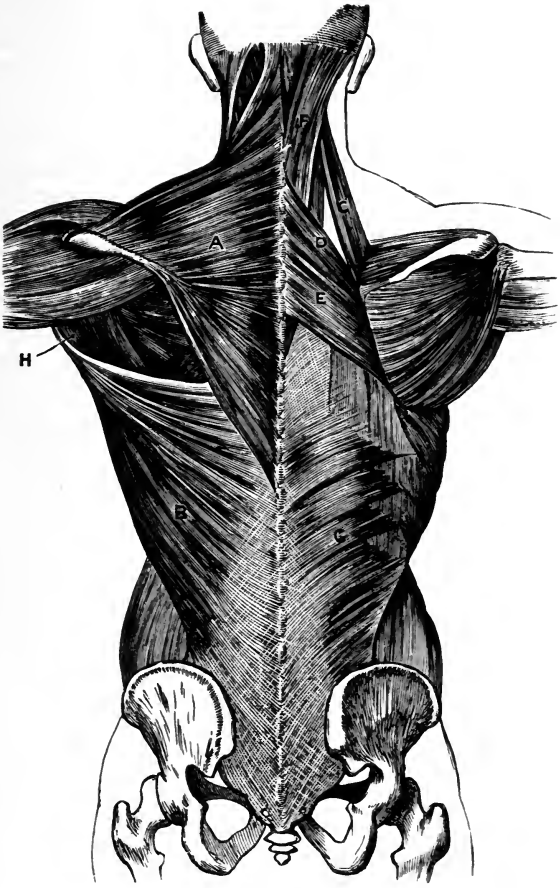


Fig. 3.—Muscles of the Back.

A. Trapezius.
B. Latissimus dorsi.
C. Levator anguli scapulæ.
D. Rhomboideus minor.
E. Rhomboideus major.
F. Splenius.
G. Serratus posticus inferior.

On the left side the first layer is shown, and on the right side the second layer, with part of the third.

line of the occipital bone. From this origin the fibres are directed outwards, converging to the shoulder, and are *inserted* into the outer third of the clavicle (fig. 5, p. 18), at its posterior aspect, into the inner border of the acromion, and into the upper border insertion:

of the spine of the scapula as far as an inch from the root of that process, as well as into a rough prominence on the lower margin of the spine near the inner end (fig. 12, p. 32).

relations; The muscle is subcutaneous. The lowest fleshy fibres end in a small triangular tendon, which glides over the smooth surface at the root of the spine of the scapula. The upper edge forms the hinder boundary of the posterior triangular space of the neck. By its insertion the trapezius corresponds with the origin of the deltoid muscle, which covers the shoulder.

action; *Action.* If all the fibres of the muscle act, the scapula gliding on the ribs is moved upwards and towards the spinal column; but the upper fibres can assist other muscles in elevating, and the lower fibres will help in depressing that bone.

in rotation of bone. When the scapula is prevented from gliding on the ribs, the trapezius imparts a rotatory movement to it by raising the acromion, and thereby assists in raising the arm above the horizontal when it has been brought up to that position away from the body by other muscles.

Division of the trapezius: **Dissection.** The dissectors of the head and neck and upper limb will now in their different parts divide the trapezius muscle vertically about two inches from its vertebral attachment, and the parts will be reflected inwards and outwards respectively. The

inner part reflected; inner portion is thin, and after it has been turned up the ligamentum nuchæ from which it arises in the middle line of the neck will be brought into view.

The LIGAMENTUM NUCHÆ is a fibrous band, which extends from the spinous process of the seventh cervical vertebra to the external occipital protuberance. From its deep surface a thin lamina of fibres is sent forwards to be attached to the external occipital crest and to the spines of the cervical vertebræ above the seventh, and thereby a median partition between the muscles of the two sides of the neck is formed.

outer part reflected. **Dissection.** The stout outer part of the trapezius should be carefully reflected, and in the somewhat tough subjacent tissue a large nerve—*the spinal accessory*—will be found running downwards and outwards from the neck on to the deep surface of the muscle. More or less parallel with the spinal accessory, but below it, two smaller nerves, from the third and fourth cervical, will then be made out. Branches of the *superficial cervical artery* will also be seen entering the muscle in the same neighbourhood.

Spinal accessory nerve in trapezius. The SPINAL ACCESSORY NERVE (the eleventh cranial), having crossed the posterior triangle of the neck, passes beneath the trapezius, and forms a plexiform union with the branches of the third and fourth nerves of the cervical plexus. The nerve can be followed nearly to the lower border of the muscle.

Clean parts beneath: **Dissection.** The *parts covered by the trapezius* will next be cleaned.

beneath the clavicle; The dissector of the neck is responsible for displaying the structures which lie deeply in the neck beneath the clavicle, but the worker on the upper limb will take note of them later on. The parts in question are the posterior belly of the omohyoid muscle

with the suprascapular nerve and vessels, the transverse cervical vessels from which the superficial cervical already referred to will be seen to spring, and the small nerves to the levator anguli scapulæ and rhomboid muscles.

The dissector of the upper limb will find three muscles proceeding from the vertebral column to the vertebral border of the scapula, viz., the levator anguli scapulæ, the rhomboideus minor and major, from above downwards, and these should be cleaned in the direction of their fibres. The rhomboideus minor and major muscles are often blended together. muscles attached to the scapula.

Beneath the lowest part of the reflected trapezius a thin fibrous lamina (aponeurosis), from which the upper part of the latissimus dorsi muscle takes origin from the lower dorsal spines, will be revealed, and care should be taken that it is not cut away.

The LATISSIMUS DORSI (fig. 3, B) is the widest muscle of the back, and is thin and aponeurotic at its attachment to the spine and pelvis. It *arises* along the middle line from the spinous processes of the six lower dorsal, all the lumbar, and the upper sacral vertebræ, as well as from the supraspinous ligaments. On the outer side it arises from the posterior third of the outer edge of the iliac crest by its aponeurosis, and from the lowest three or four ribs by as many fleshy processes, which interdigitate with slips of the external oblique muscle of the abdomen. And in many bodies it receives another fleshy slip from the inferior angle of the scapula. The fibres are directed outwards and upwards, converging rapidly; and the muscle, much reduced in breadth, turns round the lower border of the teres major, to be *inserted* by tendon into the bottom of the bicipital groove of the humerus (fig. 17, p. 44), where it will be subsequently seen. Latissimus dorsi: origin from spine, pelvis, ribs; insertion into humerus;

The muscle is superficial, except at the upper and inner part, where it is covered to a small extent by the trapezius. Farther out there is a space between the two, in which the rhomboid and infraspinatus muscles appear. The outer border overlaps the edge of the external oblique muscle of the abdomen in the interval between the last rib and the iliac crest. The aponeurosis of the latissimus is in its lower part incorporated in the posterior layer of the fascia lumborum, of which it forms the chief constituent. relations;

Action. If the arm is hanging loose, the muscle can move it behind the back, rotating it inwards at the same time. If the limb is raised, the latissimus, combining with the large pectoral and teres muscles, will depress the humerus. use when the limb is free,

Supposing the arm fixed, the latissimus assists the pectoralis major in drawing the movable trunk towards the humerus, as in the act of climbing. and fixed.

Dissection. The latissimus is to be divided about midway between the spines of the vertebræ and the angle of the scapula, and the pieces are to be reflected inwards and outwards. In raising the inner half of the muscle, care must be taken not to destroy either the thin lower serratus muscle, with which it is united, or the aponeurosis continued downwards from the serratus. Dissection to reflect latissimus.

In the interval between the last rib and the iliac crest the latissimus is adherent to the aponeurosis of the transversalis abdominis muscle, and should not be detached from it.

Parts beneath latissimus.

Parts covered by the latissimus. The latissimus dorsi lies on the erector spinæ, the serratus posticus inferior, the lower ribs with their intercostal muscles, and the lower angle of the scapula, with parts of the rhomboideus major, infraspinatus, and teres major muscles. Nearer the humerus it turns round the teres major, and is placed in front of that muscle at its insertion. In passing from the chest to the arm, the latissimus forms part of the posterior boundary of the axilla.

Second muscular layer.

The SECOND LAYER OF MUSCLES (fig. 3, C, D, E), comprising the elevator of the angle of the scapula, and the large and small rhomboid muscles are now to be examined, as well as the posterior belly of the omohyoid muscle, the suprascapular artery and nerve, and the transverse cervical artery and its branches, already referred to (p. 7).

Levator anguli scapulæ:

The LEVATOR ANGULI SCAPULÆ (fig. 3, C) arises by tendinous slips from the posterior tubercles of the transverse processes of the upper four cervical vertebræ. The fibres form an elongated muscle, which is *inserted* into the base of the scapula between the spine and the superior angle (fig. 12, p. 32).

relations

At its origin the levator lies beneath the sterno-mastoid, and, at its insertion, beneath the trapezius, where it meets the serratus magnus muscle; the rest of the muscle appears in the posterior triangular space of the neck. Beneath it are some of the other cervical muscles, viz., splenius colli and cervicalis ascendens.

and use on scapula,

Action. The muscle raises the angle and hinder part of the scapula, and depresses the acromion; but in combination with the upper fibres of the trapezius, which prevent the rotation down of the acromion, it shrugs the shoulder.

on the neck.

When the shoulder is fixed, the neck can be bent to the side by the levator.

Rhomboid muscles.

RHOMBOIDEI MUSCLES. The muscular layer of the rhomboidei is attached to the base of the scapula, and consists of two pieces, large and small, which are usually separated by a slight interval.

Small muscle.

The RHOMBOIDEUS MINOR (fig. 3, D) is a thin narrow band, which *arises* from the spines of the seventh cervical and first dorsal vertebræ, and the ligamentum nuchæ, and is *inserted* into the base of the scapula, opposite the smooth surface at the root of the spine (fig. 12).

Large muscle:

The RHOMBOIDEUS MAJOR (fig. 3, E) is much larger than the preceding muscle. It *arises* from the spines of four or five dorsal

origin;

vertebræ below the rhomboideus minor, and from the supraspinous ligaments; and its fibres are directed outwards and downwards to be

insertion;

inserted into the base of the scapula between the spine and the lower angle (fig. 12). Sometimes the upper fibres are not fixed to the scapula directly, but end on a tendinous arch passing down the bone.

relations.

The rhomboidei are for the most part covered by the trapezius and latissimus; but a portion of the larger muscle is subcutaneous near the scapula.

Action. From the direction of their fibres both rhomboidei will draw the base of the scapula upwards and backwards, so as to depress the acromion. In combination with the trapezius they carry the scapula directly back; and acting with the serratus magnus, they serve to fix the scapula. Use by themselves, with others.

The OMOHYOID MUSCLE consists of two fleshy bellies, anterior and posterior, which are united by an intervening tendon. Only the posterior half is now seen. Posterior belly of omohyoid:

The muscle *arises* from the upper border of the scapula behind the notch, and from the ligament converting the notch into a foramen. The fibres form a thin, riband-like muscle, which is directed forwards across the lower part of the neck, and ends anteriorly in a tendon beneath the sterno-mastoid muscle. This belly is partly placed beneath the trapezius, and is partly superficial in the posterior triangular space of the neck, where it lies above the clavicle and the subclavian artery, and crosses the brachial plexus and the suprascapular nerve. origin and termination; relations.

Action. The use of the muscle will be considered in the neck.

The SUPRASCAPULAR ARTERY is a branch of the subclavian, and is directed outwards through the lower part of the neck to the upper border of the scapula. It runs behind the clavicle, and crosses the suprascapular ligament in front of the posterior belly of the omohyoid muscle, to enter the supraspinous fossa. Its termination on the dorsum of the scapula will be seen in the dissection of the shoulder (p. 38). Before entering the fossa it gives off a *supra-acromial branch*, which perforates the trapezius muscle, and ramifies over the acromion. Supra-scapular artery: offset.

The SUPRASCAPULAR NERVE is an offset of the brachial plexus (fig. 8, p. 26), and inclines downwards beneath the omohyoid muscle to the notch in the upper border of the scapula, through which it passes into the supraspinous fossa (p. 38). Supra-scapular nerve.

The TRANSVERSE CERVICAL ARTERY, also a branch of the subclavian, has the same direction as the suprascapular, towards the upper angle of the scapula, but is higher than the clavicle. Crossing the upper part of the space in which the subclavian artery lies, it passes beneath the trapezius, and divides into two branches: superficial cervical and posterior scapular. Transverse cervical artery divides into

a. The *superficial cervical branch* is distributed chiefly to the under-surface of the trapezius, though it furnishes offsets to the levator anguli scapulæ and the cervical glands. superficial cervical and

b. The *posterior scapular branch* crosses under the levator anguli scapulæ, and descends along the base of the scapula beneath the rhomboid muscles. When these muscles are divided, the artery will be seen to furnish branches to them, and to give small anastomotic twigs to both surfaces of the scapula. This branch arises very frequently from the third part of the subclavian trunk as a separate artery from the superficial cervical. posterior scapular.

The *suprascapular* and *transverse cervical veins* have the same course and branches as the arteries above described; they open into the external jugular, near its junction with the subclavian vein. Accompanying veins.

Nerve of rhomboid muscles.

NERVE TO THE RHOMBOID MUSCLES. This slender offset of the brachial plexus (fig. 8, p. 26) courses beneath the elevator of the angle of the scapula, and is distributed to the rhomboidei on their deep surface. Before its termination it supplies one or two twigs to the elevator of the scapula.

Dissection. The levator anguli scapulæ and the rhomboid muscles are now to be divided about half-way between their origin and insertion, and the parts turned inwards and outwards. The small nerve to the rhomboids will be found running down to the deep surface of the muscles about an inch to the inner side of the upper angle of the scapula, and the posterior scapular artery running close to the vertebral border of the scapula beneath the rhomboid attachment will be traced out. Finally, the vertebral border of the scapula will be drawn outwards, the loose connective tissue space between it and the chest-wall will be opened up, and the inner surface of the serratus magnus muscle, which is inserted into the whole length of the inner surface of this border of the bone, will be cleaned.

Serratus magnus muscle.

CHAPTER II.

DISSECTION OF THE AXILLA.

SECTION I.

THE wall of the chest and the axilla, which are described in this Section, are to be dissected in six days, so that the senior student may be free to begin work on the thorax. Time for dissection.

POSITION. The body is lying on the back, the thorax raised to a convenient height by a block, and the arm, being slightly rotated outwards, is to be placed at a right angle with the trunk, a long board being passed under the shoulders from side to side for the support of the arms when they are drawn out from the body. Position of the body.

SURFACE-MARKING. On the front of the chest is seen the prominence of the mamma, large in the female, but small and rudimentary in the male, with the nipple projecting from it near the centre. In the male the nipple is placed most frequently over the fourth intercostal space, sometimes over the fifth rib, and occasionally at a still higher or lower level. Its position in the female varies greatly with the development of the mamma. Surface-marking. Mammary gland: nipple.

Between the arm and the chest is the hollow of the axilla, in the outer part of which the large vessels and nerves of the limb are lodged. The extent of this hollow may be seen to vary much with the position of the limb to the trunk; for in proportion as the arm is elevated, the folds bounding it in front and behind are carried upwards and rendered tense, and the depth of the space is diminished. In this part the skin is of a dark colour, and is furnished with hairs and large sweat-glands. Armpit.

If the arm is forcibly raised and moved in different directions, while the fingers of one hand are placed in the armpit, the head of the humerus may be recognised. Head of the humerus.

On the outer side of the limb is the prominence of the shoulder; and immediately above it is an osseous arch, which is formed in front by the clavicle, behind and externally by the spine and the acromion process of the scapula. Continued downwards from about the middle of the clavicle is a slight depression between the pectoral and deltoid muscles, and by pressing the fingers into this hollow the coracoid process of the scapula can be made out. A second groove, extending outwards from the sternal end of the Shoulder arch of bone. Intermuscular depressions.

clavicle, corresponds with the interval between the clavicular and the sternal origins of the great pectoral muscle.

Arm: its prominence and grooves.

Along the front of the arm is the prominence of the biceps muscle; and on each side of that eminence is a groove, which subsides inferiorly in a depression in front of the elbow-joint. The groove on the inner side of the biceps is the deeper, and indicates the position of the brachial vessels.

Prominences around the elbow-joint.

If the elbow-joint be slightly flexed, the prominences of the outer and inner condyles of the humerus will be rendered evident, especially the inner. Below the outer condyle, and separated from it by a slight interval, the head of the radius is placed, and may be recognised by rotating that bone, the fingers at the same time being placed over the head. At the back of the elbow is the prominence of the olecranon, and to the outer side of this, when the forearm is fully bent, a projection is formed by the capitellum.

Dissection. The first step in the dissection is to raise the skin from the side of the chest and the armpit, over the great pectoral muscle and the hollow of the axilla, by means of the following

Incisions.

incisions:—*One* is to be made along the middle of the sternum (fig. 1, B. 2). *A second* is carried along the whole length of clavicle and continued downwards over the outer side of the shoulder for about three inches (fig. 1, B. 5). From the lower end of the sternum *a third* cut is to be directed outwards over the side of the chest, as far back as to a level with the posterior fold of the armpit (fig. 1, B. 7), and *a fourth* is taken upwards and outwards from the lower end of the sternum along the anterior folds of the axilla on to the arm opposite the lower end of the shoulder cut (fig. 1, B. 6).

Reflect skin.

The flaps of skin thus marked out are to be reflected outwards beyond the axilla; but they should be left attached to the body, in order that they may be used for the preservation of the part.

Superficial fascia.

The *subcutaneous fatty layer* of the thorax resembles the same structure in other parts of the body; but in this region it does not usually contain much fat.

Deep fascia:

Beneath the subcutaneous layer is the stronger *deep fascia*, which closely invests the muscles, and is continuous with the fascia of the arm. It is thin on the front of the chest, but becomes thick where

thickest over axilla.

it is stretched across the axilla. An incision through it, over the armpit, will render evident its increased strength in this situation, and the casing that it gives to the muscles bounding the axilla; and if the forefinger be introduced through the opening, some idea will be gained of its capability of confining an abscess in that hollow.

Cutaneous nerves:

Dissection. The cutaneous nerves of the side of the chest are first to be sought. At the spots where they are to be found they are placed beneath the fat, which must be cut through to expose them; and those over the clavicle lie also beneath the superficial platysma muscle. Small vessels for the most part accompany the nerves, and indicate their position.

from cervical plexus

Some of the nerves (from the cervical plexus) cross the clavicle at the middle, and the inner end. Others (*anterior cutaneous* of the thorax) appear at the side of the sternum,—one through each inter-

costal space. And the rest (*lateral cutaneous* of the thorax) should be looked for along the side of the chest, about an inch behind the anterior fold of the axilla, there being one from each intercostal space except the first. As these last-mentioned nerves pierce the wall of the thorax, they divide into anterior and posterior branches. The posterior branches of the highest two of them are larger than the rest, and are to be followed across the armpit, where a junction will be found with a branch (nerve of Wrisberg) of the brachial plexus.

and intercostal nerves;

nerve of Wrisberg.

CUTANEOUS NERVES FROM THE CERVICAL PLEXUS. These cross the clavicle and are distributed to the skin over the pectoral muscle. The most internal branch (sternal) lies near the inner end of the bone, and reaches but a short distance below it. Other branches (clavicular), two or more in number and larger, cross the middle of the clavicle, and extend to near the lower border of the pectoralis major; they join one or more of the anterior cutaneous nerves.

Cutaneous nerves of cervical plexus.

The CUTANEOUS NERVES OF THE THORAX are derived from the trunks of the intercostal nerves between the ribs. Of these there are two sets:—One set, the *lateral cutaneous nerves*, arise about midway between the spinal column and the sternum. The other set, the *anterior cutaneous nerves*, are the terminations of the same trunks at the anterior ends of the intercostal spaces.

Cutaneous branches of intercostals.

The ANTERIOR CUTANEOUS NERVES are slender filaments which pierce the pectoral muscle, and are directed outwards to supply the skin and the mammary gland. The offset of the second nerve joins a cutaneous branch from the cervical plexus. Small branches of the internal mammary vessels accompany these nerves.

One near middle line.

The LATERAL CUTANEOUS NERVES (fig. 4, p. 15) issue with companion vessels between the digitations of the serratus magnus muscle, and divide into anterior and posterior branches. There is not usually any lateral cutaneous nerve from the first intercostal trunk.

The other on side of the chest;

The *anterior offsets* (fig. 4 [9], p. 15) bend over the pectoral muscle, and end in the integuments and the mammary gland; they increase in size downwards, and the lowest give twigs to the digitations of the external oblique muscle. The cutaneous nerve of the second intercostal trunk commonly wants the anterior offset.

these have anterior and

The *posterior offsets* (fig. 4 [8], p. 15) end in the integuments over the latissimus dorsi muscle and the back of the scapula, and decrease in size from above downwards.

posterior branches.

The lateral branch of the second intercostal nerve (fig. 4 [7], p. 15) is larger than the rest, and is named the *intercosto-humeral*. Perforating the fascia of the axilla, it is distributed to the skin of the arm (p. 43). As it crosses the axilla it is divided into two or more pieces, and is connected to the nerve of Wrisberg, or *lesser internal cutaneous*, by a filament of variable size.

One reaches the arm.

The branch of the third intercostal nerve gives filaments likewise to the armpit and the inner side of the arm.

Third nerve.

The MAMMA is the gland for the secretion of the milk, and is situate on the lateral part of the front of the chest.

The breast:

form and position; with its dimensions and weight.

Resting on the great pectoral muscle, it is nearly hemispherical in form, but most prominent at the inner and lower aspects. Its dimensions and weight vary greatly. In a breast not enlarged by lactation, the width is commonly about four inches. Longitudinally it extends from the third to the sixth or seventh rib, and transversely from the side of the sternum to the axilla. Its thickness is about one inch and a half. The weight of the mamma ranges from six to eight ounces.

Position and form of the nipple; the areola; colour is variable; skin has glands.

Nearly in the centre of the gland (rather to the inner side) rises the conical or cylindrical projection of the nipple or *mamilla*. This prominence is about half an inch or rather more in length, is slightly turned outwards, and presents in the centre a shallow depression, where it is rather redder. Around the nipple is a coloured ring—the *areola*, about an inch in width, the tint of which is influenced by the complexion of the body, and becomes darker during pregnancy and lactation. The skin of the nipple and areola is provided with numerous papillæ and glands; and on the surface are some small tubercles marking the position of the latter.

Breast of the male.

In the male the mammary gland resembles that of the female in general form, though it is much less developed; and it possesses a small nipple, which is surrounded by an areola provided with hairs. The glandular or secretory structure is imperfect.

Structure.

Structure. The mamma is a compound racemose gland, and consists of small vesicles, which are united to form lobules and lobes, and connected with each lobe is an excretory or lactiferous duct.

Investing and fibrous tissue.

A layer of areolar tissue, containing masses of fat, surrounds the gland, and penetrates into the interior, subdividing it into lobes; but between the lobules of the gland, and in the nipple and areola, there is not any fatty substance. Some fibrous septa fix the gland to the skin, and support it, being spoken of as the *ligamenta suspensoria* of Astley Cooper.

Lactiferous ducts; open on end of nipple.

The *ducts* issuing from the several lobes (about twenty) are named from their office *galactophorous;* they converge to the areola, where they swell into oblong dilatations or reservoirs (sinuses) of one-sixth to one-third of an inch in width. Onwards from that spot the ducts become narrower; and, surrounded by areolar tissue and vessels, they are continued through the nipple, nearly parallel to one another, to open on the summit by apertures smaller than the canals, and varying from the size of a bristle to that of a common pin.

Muscular tissue in nipple.

Nipple. The substance of the nipple is composed in great part of a network of interlacing bundles of plain muscular tissue, through which the lactiferous ducts pass to the surface. Some of the bundles extend from base to apex of the nipple; and surrounding the base is a set of circular fibres, with which radiating bundles decussate.

Arteries of the gland

Blood-vessels.—The *arteries* are supplied by the axillary, internal mammary, and intercostal, and enter both surfaces of the gland. The *veins* end

principally in the axillary and internal mammary trunks ; but others enter the intercostal veins. and veins.

The *nerves* are supplied from the anterior and lateral cutaneous branches of the thorax, viz., from the third, fourth, and fifth intercostal nerves. Nerves.

The *lymphatics* of the inner side open into the sternal glands ; those of the outer side pass to the axillary glands. Lymphatics.

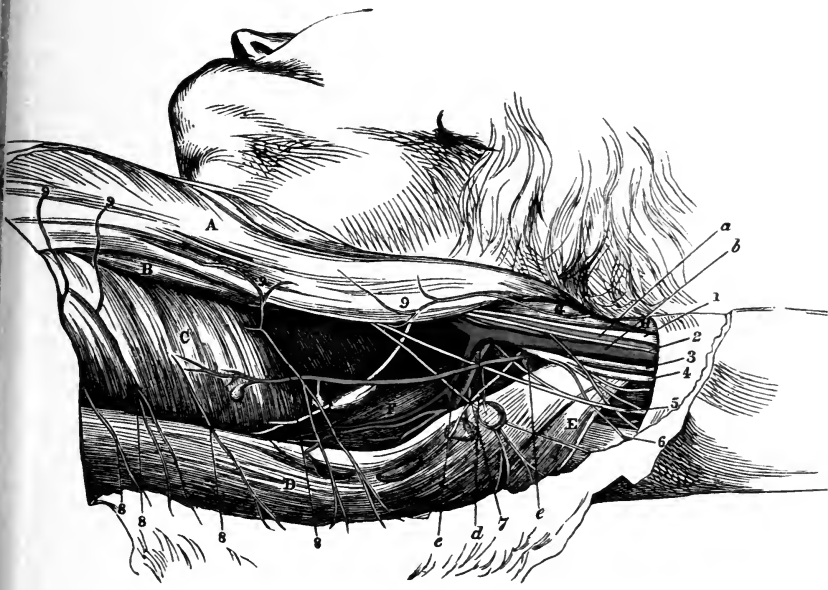


Fig. 4.—View of the Dissected Axilla (Illustrations of Dissections).

Muscles :

A. Pectoralis major.
B. Pectoralis minor.
C. Serratus magnus.
D. Latissimus dorsi.
E. Teres major.
F. Subscapularis.
G. Coraco-brachialis.
H. Biceps.

Vessels :

a. Axillary artery.
b. Axillary vein.
c. Subscapular vein.
d. Subscapular artery.
e. Posterior circumflex artery.

Nerves:

1. Median.
2. Internal cutaneous.
3. Ulnar.
4. Musculo-spiral.
5. Nerve of Wrisberg.
6. Internal cutaneous of musculo-spiral.
7. Intercosto-humeral.
8. Posterior } branches of lateral
9. Anterior } cutaneous of the thorax.

Dissection (fig. 4). With the limb drawn outwards (abducted) from the trunk, the student should now remove the fascia and the fat from the surface of the great pectoral muscle. In cleaning the muscle the scalpel should be carried in the direction of the fibres, viz. from the arm to the thorax ; and the dissection may be begun Dissection of pectoral muscle.

at the lower border on the right side, but at the upper border on the left side. In the groove at the upper border, between the pectoralis major and the deltoid, a small vein, *the cephalic*, will be seen, and subjacent to this a small artery, the descending or *humeral branch of the acromio-thoracic*, will be found running downwards.

Remove fat of axilla.

The fascia and the fat are then to be taken from the axilla, without injury to the numerous vessels, nerves, and glands in the space. The dissection will be best executed by cleaning first the large axillary vessels at the outer part, where these are about to

Follow vessels.

enter the arm, and then following their branches which are directed to the chest, viz., the long thoracic under cover of the anterior boundary of the armpit, and the subscapular along the posterior boundary. With the latter vessels the middle and lower subscapular nerves will be found, and just below them at their origin, turning backwards near the humerus, are the posterior circumflex artery and the circumflex nerve. Some arterial twigs entering the axillary glands should also be traced out.

Clean back of space.

In taking away the fascia and fat from the muscles at the back of the space, the small internal cutaneous branch of the musculo-spiral nerve (fig. 4^6) should be looked for near the great vessels.

Trace nerves of plexus,

The nerves of the brachial plexus about the axillary vessels in the outer part of the space are then to be defined. The smallest of these, which is commonly destroyed, is the nerve of Wrisberg ; it lies close to the hinder edge of the axillary vein, and joins with the intercosto-humeral nerve.

and on inner wall.

Finally, when cleaning the serratus magnus muscle on the ribs, the student will seek on its surface for the posterior or long thoracic nerve (fig. 6^4, p. 21) which runs down longitudinally towards the back part of the muscle. The posterior offsets of the intercostal nerves crossing the axilla will also be cleaned.

THE AXILLA.

Situation and form of the armpit.

The axilla is the hollow between the arm and the chest (fig. 4). It is somewhat pyramidal in form, with its apex directed upwards to the root of the neck. The space is larger near the thorax than at the arm, and its boundaries are as follows :—

Boundaries : anterior wall ;

Boundaries. In front and behind, the space is limited by the muscles passing from the trunk to the upper limb. In the *anterior wall* are the two pectoral muscles, but these take unequal shares in its construction : the pectoralis major (A*) extends over the whole front of the space, reaching from the clavicle to the edge of the anterior fold ; while the pectoralis minor (B) corresponds only to about the middle third of the wall.

posterior wall.

In the *posterior wall*, from above downwards, lie the subscapularis (F), the latissimus dorsi muscle (D), and the teres major (E) muscles. The free margin of this wall, or the posterior fold, is formed by the latissimus dorsi and teres major muscles, and is

* The letters and figures refer to fig. 4.

thicker and more prominent than the anterior, especially near the arm.

Inner wall; On the inner wall of the axilla lie the first five ribs, with their intervening intercostal muscles, and the part of the serratus magnus (C) taking origin from those bones. outer wall; On the outer side the space has but small dimensions, and is limited by the humerus and the coraco-brachialis and biceps muscles (G and H).

apex; The apex of the hollow is situate between the clavicle, the upper margin of the scapula, and the first rib; and the forefinger may be introduced into the space for the purpose of ascertaining the upper boundaries, and the depth. base. The base of the pyramidal fossa is turned downwards, and is closed by the thick aponeurosis reaching from the anterior to the posterior fold.

Contents of the space. *Contents of the space.* In the axilla are contained the axillary vessels and the brachial plexus of nerves with their branches; some branches of the intercostal nerves; together with lymphatic glands, and a large quantity of loose areolar tissue and fat.

Position of large vessels; *Position of the trunks of vessels and nerves* (fig. 4). The large axillary artery (*a*) and vein (*b*) cross the outer portion of the space in passing from the neck to the upper limb. The part of each vessel now seen lies close to the humerus, reaching beyond the line of the anterior fold of the armpit, and is covered only by the common superficial coverings, viz., the skin, the fatty layer or superficial fascia, and the deep fascia. Behind the vessels are the subscapularis (F) and the tendons of the latissimus and teres muscles (D and E). To their outer side is the coraco-brachialis muscle (G).

vein; On looking into the space from below, the axillary vein (*b*) lies on the thoracic side of the artery.

nerves. After the vein has been drawn aside, the artery will be seen to lie amongst the large nerves of the upper limb, having the median trunk ([1]) to the front and outer side, and the ulnar ([3]) and the small nerve of Wrisberg ([5]) to the inner side, the internal cutaneous ([2]) to the inner side and somewhat in front, and the musculo-spiral ([4]) and circumflex nerves beneath it. This part of the artery gives branches to the side of the chest and the shoulder. The vein receives some branches in this spot.

Situation of branches: *Position of the branches of vessels and nerves.* The several branches of the vessels and nerves have the undermentioned position with respect to the boundaries of the axilla.

in front; Close to the anterior fold, and concealed by it, the long thoracic artery runs to the side of the chest. Taking the same direction, though nearer the middle of the hollow, a small external mammary artery and vein are occasionally present.

behind; Passing down the posterior wall, within the free margin of the fold in contact with the lower edge of the subscapularis muscle, are the subscapular vessels and nerves (*d*); and near the outer, humeral, end of the subscapularis the posterior circumflex vessels (*e*) and the circumflex nerve bend backwards beneath the large trunks.

inside,

On the inner boundary, at the upper part, are a few small branches of the superior thoracic artery, which ramify on the serratus muscle; but these are commonly so unimportant, that this part of the axillary space may be considered free from vessels with respect to any surgical operation. Running down the outer surface of the serratus magnus towards the back of the axilla is the nerve to that muscle (long or posterior thoracic); and coming through the inner wall of the space, under cover of the pectoral muscles, are the lateral cutaneous nerves of the thorax, the highest of which is directed across the axilla to the arm, and receives the name intercosto-humeral (7).

Lymphatic glands of the axilla

The *lymphatic glands* of the axilla are arranged in three sets: one is placed along the inner side of the great blood-vessels; another occupies the hinder part of the space, lying near the subscapular vessels; and the third accompanies the long thoracic artery, beneath the margin of the pectoralis major. Commonly there are in all ten or twelve; but in number and size they vary much. Small twigs from the branches of the axillary vessels are furnished to them.

and vessels joining them.

The glands by the side of the blood-vessels receive the lymphatics of the arm; those along the hinder boundary are joined by the

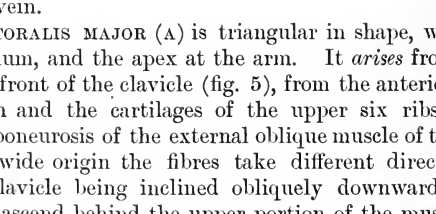


Fig. 5.—The Clavicle, showing the Upper and a Part of the Anterior Surface.

lymphatics of the side of the chest and of the back, and those beneath the pectoral muscle by the lymphatics of the front of the chest, and from the outer part of the mamma. The efferent vessels unite to form a trunk, which opens into the lymphatic duct of the neck of the same side; or some may enter separately the subclavian vein.

Pectoralis major;

The pectoralis major (a) is triangular in shape, with the base at the sternum, and the apex at the arm. It *arises* from the inner half of the front of the clavicle (fig. 5), from the anterior surface of the sternum and the cartilages of the upper six ribs, and below from the aponeurosis of the external oblique muscle of the abdomen.

origins;

From this wide origin the fibres take different directions—those from the clavicle being inclined obliquely downwards, while the lower ones ascend behind the upper portion of the muscle; and all

insertion;

end in a tendon, which is *inserted* (fig. 17, p. 44) into the pectoral ridge on the outer side of the bicipital groove of the humerus, along which a thin prolongation is sent upwards to the head of the bone.

relations.

This muscle bounds the axilla in front, and its lower border

forms the anterior fold of the hollow. Covering it are the integuments, with the mamma and the thin deep fascia, as well as the platysma close to the clavicle. The upper border is adjacent to the deltoid muscle, the cephalic vein, and a small artery lying between the two. Between the clavicular and sternal origins is a narrow interval, which corresponds to a depression on the surface. The parts beneath the pectoralis major will be seen subsequently.

Action. If the humerus is hanging, the muscle will move forwards the limb until the elbow reaches the front of the trunk, and will rotate it inwards. Use: flexes, rotates in,

When the limb is raised, the pectoralis depresses and adducts it (draws it to the side of the body); and acting with other muscles inserted into the humerus, it may dislocate the head of that bone when the lower end is raised and fixed, as in a fall on the elbow. and adducts arm;

Supposing both limbs fixed, as in climbing, the trunk will be raised by both muscles; and the lower fibres can elevate the ribs in laborious breathing. raises ribs.

Dissection (figs. 6 and 7). The great pectoral muscle is to be cut across now in the following manner :— Dissection.

Divide the clavicular part of the muscle and find the subjacent branches of nerve and artery. In reflecting the cut piece of the muscle, press the limb against the edge of the table, for the purpose of raising the clavicle and rendering tight the fascia attached to that bone. Carefully remove the fat, and a piece of fascia prolonged from the upper border of the small pectoral muscle, (the membranous costo-coracoid sheath) will be seen close to the clavicle, covering the axillary vessels and nerves. Cut clavicular part of the pectoral.

The cephalic vein is to be defined as it crosses inwards to the axillary vein. A branch of a nerve (the *external anterior thoracic*), and the *acromio-thoracic vessels*, perforate the fascia over the axillary trunks, and are to be followed to the clavicular part of the pectoral muscle. A second branch of the external anterior thoracic nerve, with accompanying arteries, will be found passing downwards over the upper border of the pectoralis minor into the sternal part of the major muscle. These nerves and arteries should now be cleaned. Trace vessels and nerves.

The remaining part of the pectoralis major may then be cut about its centre, and the pieces thrown inwards and outwards. Any fat coming into view is to be removed; and the tendon of the pectoralis is to be followed to the humerus. In raising the pectoralis major note will be taken of a small nerve (*internal anterior thoracic*), which usually pierces the minor muscle to enter the lower part of the major. Divide the rest of the muscle.

Insertion of the pectoralis major. The tendon of the pectoralis consists of two layers, anterior and posterior, at its attachment to the bone;—the anterior receives the clavicular and upper sternal fibres; and the posterior gives attachment to the lower ascending thoracic fibres. The tendon is from two inches to two inches and a half wide, and sends upwards one expansion over the bicipital groove to the capsule of the shoulder-joint, and another downwards to the fascia of the arm (see humerus, fig. 17, p. 44). Tendon of pectoralis.

Parts covered by the muscle.

Parts covered by the pectoralis. The great pectoral muscle covers the pectoralis minor, and forms alone, above and below that muscle, the anterior boundary of the axilla. Between the pectoralis minor and the clavicle it conceals the subclavius muscle, the sheath containing the axillary vessels, and the branches perforating that sheath. Below the pectoralis minor it lies on the side of the chest, on the axillary vessels and nerves, and on the biceps and coraco-brachialis muscles near the humerus.

Pectoralis minor:

The PECTORALIS MINOR (figs. 6 and 7) is also triangular in shape, and extends from the thorax to the shoulder. It arises

origin;

from the third, fourth, and fifth ribs, immediately external to their cartilages, by tendinous slips which are blended with the aponeuroses

insertion;

in the intercostal spaces. The fibres converge to their insertion into the anterior half of the coracoid process of the scapula, at its upper and inner part (fig. 10, p. 29).

relations;

This muscle assists the pectoralis major in forming the anterior wall of the axilla, and near its insertion it lies over the large vessels and the accompanying nerves. The upper border is separated from the clavicle by a triangular interval. The lower border projects beyond the pectoralis major close to the chest; and along it the long thoracic vessels lie. The tendon of insertion is united with the coraco-brachialis and short head of the biceps.

use.

Action. It draws the scapula forwards and downwards; and in laborious breathing it becomes an inspiratory muscle, taking its fixed point at the shoulder.

Dissection of axillary sheath and costo-coracoid fascia.

Dissection. Supposing the clavicle raised by pressing backwards the arm, as before directed, the tube of fascia around the axillary vessels will be demonstrated by making a transverse cut below the costo-coracoid membrane so that the handle of the scalpel can be passed beneath it. Then, by dividing the membrane itself near the clavicle and raising the lower border of the subclavius, this muscle will be seen to be encased by fascia, which is attached to the bone both before and behind it.

Costo-coracoid membrane

The *costo-coracoid membrane* or *ligament* is a firm band which is attached on the inner side to the first rib, and on the outer side to the coracoid process of the scapula. Between these points it

conceals subclavius,

is inserted into the under-surface of the clavicle, enclosing the subclavius muscle (fig. 6 D). The fascia that encases the small pectoral

and joins sheath of vessels.

muscle is joined to the membrane above, and, in addition, the deep stratum of the membrane, beneath the subclavius muscle, is blended with the front of the axillary sheath.

Axillary sheath

The *sheath* of the axillary vessels and nerves (E)* is a funnel-shaped tube, prolonged from the fascia covering the scaleni muscles

strongest in front.

in the lower part of the neck. It is strongest near the subclavius muscle, where the costo-coracoid band joins it. The anterior part of the sheath is perforated by the cephalic vein (*e*), the acromio-thoracic artery (*a*), and the anterior thoracic nerves (1 and 2).

Clean the vessels.

Dissection. After the costo-coracoid membrane has been ex-

* The letters and figures refer to fig 6. In fig. 7 the parts are named.

amined, the remains of it are to be taken away; and the subclavius muscle, and the axillary vessels and nerves with their branches, are to be carefully cleaned.

The SUBCLAVIUS (fig. 6, D) is a small elongated muscle, placed below the clavicle. It *arises* by a tendon from the first rib and its cartilage at their junction, in front of the costo-clavicular ligament. The fibres pass outwards and somewhat upwards, and are *inserted* into a groove on the under-surface of the clavicle, which reaches Subclavius muscle is attached to clavicle

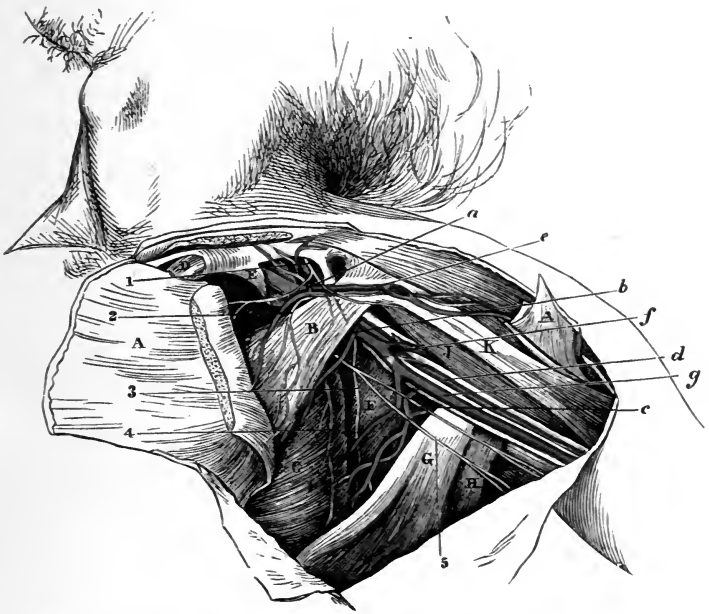


FIG. 6.—SECOND VIEW OF THE DISSECTION OF THE CHEST (ILLUSTRATIONS OF DISSECTIONS).

Muscles and fasciæ:

- A. Pectoralis major, cut.
- B. Pectoralis minor.
- C. Serratus magnus.
- D. Subclavius, encased in the costo-coracoid membrane.
- E. Axillary sheath.
- F. Subscapularis.
- G. Latissimus dorsi.
- H. Teres major.
- J. Coraco-brachialis.
- K. Biceps.

Vessels:

- *a*. Acromio-thoracic branch.
- *b*. Long thoracic branch.
- *c*. Subscapular branch.
- *d*. Axillary artery.
- *e*. Cephalic vein.
- *f*. Brachial veins joining the axillary vein, *g*.

Nerves:

- 1 and 2. Anterior thoracic branches.
- 3. Long subscapular branch.
- 4. Nerve to the serratus.
- 5. Intercosto-humeral.

and first rib: between the two rough impressions for the costo- and coraco-clavicular ligaments.

relations; The muscle crosses the large vessels and nerves of the limb, and is enclosed, as before said, in a sheath of fascia.

use. *Action.* It depresses the clavicle, and indirectly the scapula.

AXILLARY ARTERY: The AXILLARY ARTERY (figs. 6 and 7) continues the subclavian trunk to the upper limb. The part of the vessel to which this name

extent; is applied is contained in the axilla, and extends from the outer border of the first rib to the lower edge of the teres major muscle (H).

course In the axillary space its position will be marked by a line from the centre of the clavicle to the inner edge of the coraco-brachialis. Its direction will vary with the position of the limb to the trunk; for when the arm lies by the side of the body the vessel is arched, its convexity being upwards; but when the limb is raised to the

depth. level of the shoulder, it is somewhat curved in the opposite direction. In the upper part of the axilla the vessel is deeply placed, but it becomes superficial as it approaches the arm.

Its relations with the surrounding objects are numerous; and the description of these will be methodised by dividing the artery into *three parts*, the first above, the second beneath, and the third below the small pectoral muscle.

above small pectoral; *Above the small pectoral muscle*, the artery is contained in the axillary sheath of membrane (E), and is concealed by the clavicular

with muscles, portion of the great pectoral muscle. Behind it are the intercostal muscles of the first space and the first digitation of the serratus magnus.

vessels, To the thoracic side is placed the axillary vein (*g*). The cephalic vein (*e*) and offsets of the acromio-thoracic vessels cross over it.

and nerves. On the acromial side lie the cords of the brachial plexus; superficial to it is the external anterior thoracic nerve; and beneath it is the posterior or long thoracic, descending on the serratus magnus.

Beneath pectoral *In its second part*, the pectoralis minor and major (B and A) are

with muscles, superficial to the artery. But there is not any muscle immediately in contact behind, for the vessel is placed across the top of the axilla, particularly when the limb is in the position required by the dissection.

vein, The companion vein (*g*) lies to the inner side, but separated from the arterial trunk by the inner cord of the brachial plexus, which has crossed behind the artery to its inner side.

and nerves. In this position the cords of the brachial plexus lie around it, one being outside, another inside, and the third behind the artery.

And beyond the small pectoral: *Beyond the pectoralis minor*, the artery is at first concealed by

with muscles, the lower border of the great pectoral muscle (A); but thence to its termination it is covered only by the integuments and the fascia. Beneath it are subscapularis muscle (F) and the tendons of the latissimus and teres (G and H). To the outer side is the coraco-brachialis muscle (J).

with vein, The axillary vein remains on the thoracic side of the artery.

and nerves. In this, its third part, the artery lies in the midst of the large

trunks of nerves into which the brachial plexus has been resolved. On the outer side is the median nerve, with the musculo-cutaneous for a short distance ; and on the inner side are the ulnar and the nerve of Wrisberg (lesser internal cutaneous), the latter being directed behind, or sometimes through, the vein to its inner side. Superficial to the vessel is the internal cutaneous and the inner head of the median passing outwards ; and behind are the musculo-spiral and circumflex nerves, the latter extending only as far as the border of the subscapular muscle.

The BRANCHES of the axillary artery are furnished to the wall of the thorax and the shoulder. The thoracic branches are, as a rule, four in number ; two (superior and acromio-thoracic) arise from the

Branches.

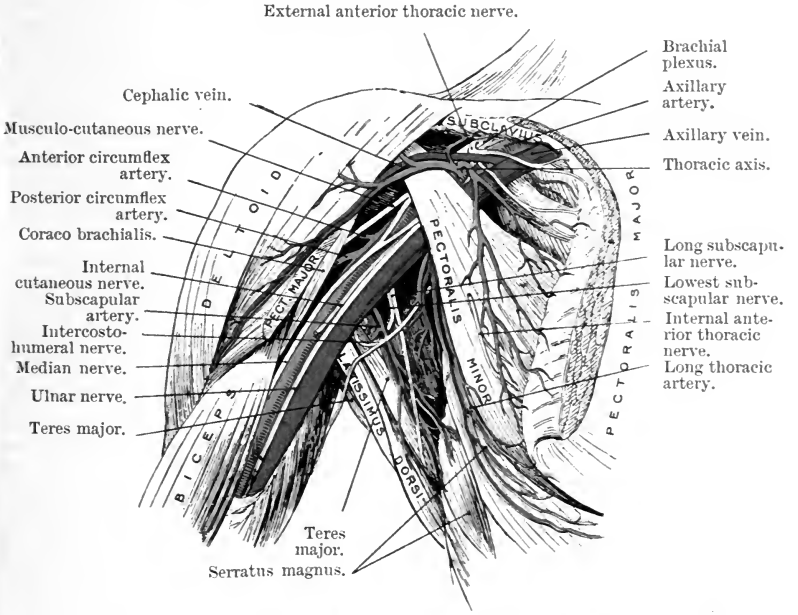


FIG. 7.—PARTS BENEATH THE PECTORALIS MAJOR (DIAGRAMMATIC).

artery above the pectoralis minor, one (alar thoracic) beneath that muscle, and one (long, or inferior, thoracic) at its lower border. Three branches are supplied to the shoulder, viz., subscapular and two circumflex ; they arise close together, at the border of the subscapularis muscle. Occasionally a small external mammary artery is present.

The *superior thoracic branch* is the highest and smallest offset, and arises opposite the first intercostal space ; it ramifies on the side of the chest, anastomosing with the intercostal arteries. Very commonly this vessel arises with the acromio-thoracic, and the trunk of origin is then spoken of as the *thoracic axis* (fig. 7).

Upper thoracic.

The *acromio-thoracic branch* is a short trunk on the front

Acromio-thoracic

of the artery, which appears at the upper border of the pectoralis minor, and opposite the interval between the large pectoral and deltoid muscles. Its principal offsets are directed inwards and outwards :—

offsets are internal,

a. The *inner* or *thoracic set* supply the pectoral muscles, and give a few offsets to the side of the chest, which anastomose with the intercostal and other thoracic arteries.

external,

b. The *outer* or *acromial set* enter the deltoid, and some twigs perforate that muscle to anastomose over the acromion with a branch of the suprascapular artery.

ascending,

c. A small *clavicular branch* ascends to the subclavius muscle.

and descending.

d. The *humeral branch* runs downwards with the cephalic vein between the pectoral and deltoid muscles, to which it is distributed.

Alar thoracic.

The *alar thoracic* is very inconstant as a separate branch, its place being frequently taken by offsets of the subscapular and long thoracic arteries; it is distributed to the glands and fat of the axilla.

Long thoracic.

The *long thoracic branch* is directed along the border of the pectoralis minor to about the fifth intercostal space; it supplies the pectoral and serratus muscles, and anastomoses, like the other branches, with the intercostal and thoracic arteries. In the female it gives branches to the mammary gland.

External mammary.

An *external mammary artery* is frequently met with, especially in the female; its position is near the middle of the axilla with a companion vein. It supplies the glands, and ends in the wall of the thorax below the long thoracic.

Subscapular

The *subscapular branch* courses with a nerve of the same name along the subscapularis muscle, just within the fold of the latissimus dorsi, as far as the lower angle of the scapula, where it ends in branches for the serratus magnus, latissimus dorsi, and teres major muscles. It also gives many off-sets to the glands of the space.

dorsal branch,

Near its origin the artery sends backwards a considerable *dorsal branch* round the lower border of the subscapular muscle, which

which give infra-scapular.

gives an *infrascapular offset* to the ventral aspect of the scapula, and then turns to the dorsum of that bone, where it will be afterwards dissected (p. 38).

The subscapular artery is frequently combined at its origin with other branches of the axillary, or with branches of the brachial artery.

Anterior and posterior circumflex.

The *circumflex branches* wind round the humerus below the subscapular muscle. The *anterior* is small, and passes outwards beneath the coraco-brachialis and biceps, and should be looked for by drawing the axillary artery a little away from the coraco-brachialis muscle. The *posterior* is much larger, and disappears with the companion nerve between the subscapularis and teres major muscles. They will be followed in the dissection of the shoulder.

Muscular.

Small *muscular offsets* enter the coraco-brachialis muscle.

Axillary vein:

The AXILLARY VEIN (*g*) continues upwards the basilic vein of the arm, and has the same extent as the axillary artery. It lies to

the thoracic side of its artery, and receives corresponding thoracic and shoulder branches. Opposite the subscapular muscle it is joined externally by a large vein, which is formed by the union of the venæ comites of the brachial artery; and near the clavicle the cephalic vein opens into it. extent and relations; branches.

Dissection. The continuity of the axillary with the subclavian artery will now be displayed by removing the middle third of the clavicle and the subjacent portion of the subclavius muscle and cleaning the vessel beneath the bone. After this the dissector will follow out the branches of the brachial plexus, cut through the pectoralis minor near its insertion into the coracoid process, and turn it towards the chest, but without injuring the thoracic nerves. The axillary vessels are next to be ligatured, divided below the second rib above the ligature, and to be drawn down with hooks, care being taken to preserve the loop of communication between the external and the internal anterior thoracic nerves; and their thoracic branches may be removed at the same time. A dense fascia is to be cleared away from the large nerves of the plexus. Dissection of brachial plexus.

The BRACHIAL PLEXUS (figs. 7 and 8) results from the interlacement of the anterior branches of the lower four cervical nerves and the larger part of the first dorsal; and a slip is added to it above from the fourth cervical nerve. It is placed successively in the neck and the axilla, and ends opposite the coracoid process in the nerves of the limb. The part of the plexus above the clavicle is described in the dissection of the head and neck. The part below the clavicle has the same relations to surrounding muscles as the axillary artery; and in it the nerve-trunks are disposed as follows:— Nerves entering brachial plexus. Its situation and relations.

As the plexus enters the axilla it consists of three cords, inner, outer, and posterior, which lie together in a bundle on the outer side of the artery. Beneath the pectoralis minor the three cords embrace the vessel, being placed as their names indicate—the first inside, the second outside, and the third behind the artery. Near the lower edge of the small pectoral muscle, the cords divide to form the large nerves of the limb. The nerves form three cords around the artery,

The *branches* of the plexus below the clavicle arise from the several cords in the following way (fig. 8):— branches:

The *outer cord* furnishes one anterior thoracic branch (eat), the musculo-cutaneous (mc), and the outer head of the median nerve (m). outer cord;

The *inner cord* gives origin to a second anterior thoracic nerve (iat), the internal cutaneous (ic), the nerve of Wrisberg (w), the inner head of the median (m), and the ulnar nerve (u). inner cord;

The *posterior cord* furnishes the subscapular branches (s1, s2, and s3), and ends in the circumflex (c) and musculo-spiral (ms) trunks. posterior cord.

Only the thoracic and subscapular nerves are exposed to their termination at present; the remaining nerves will be seen in the subsequent dissections. The following are seen now, viz.—

The *anterior thoracic branches* (fig. 6, [1] and [2], p. 21, and fig. 7, p. 23), two in number, are named outer and inner, like the cords from which they come. two anterior thoracic:

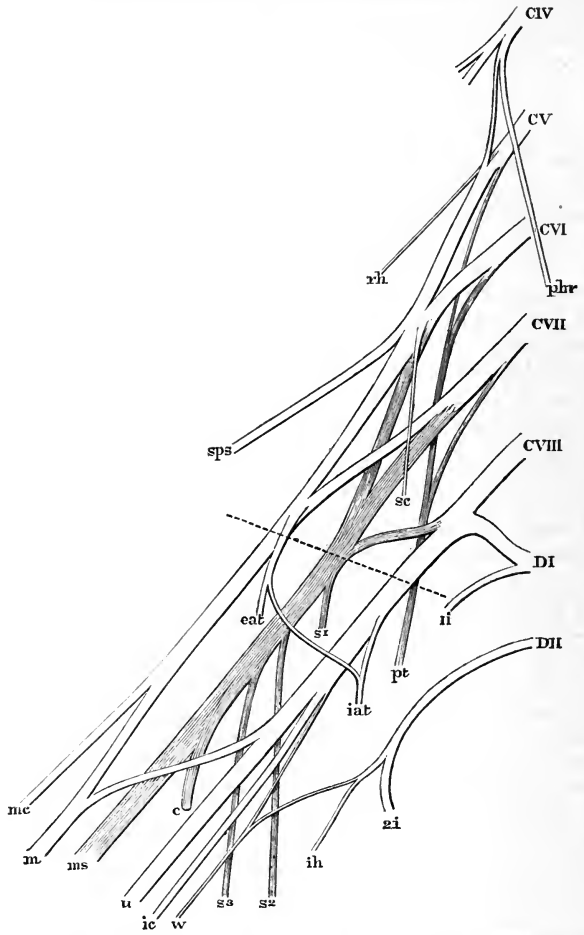


FIG. 8.—DIAGRAM OF THE BRACHIAL PLEXUS. THE DOTTED LINE INDICATES THE LEVEL AT WHICH THE CORDS ARE CROSSED BY THE CLAVICLE.

C IV. to C. VIII. Fourth to eighth cervical nerves.
D I. and D II. First and second dorsal nerves.
1 i and 2 i. First and second intercostal nerves.
ih. Intercosto-humeral nerve.
phr. Phrenic nerve.

Supraclavicular branches of brachial plexus :

rh. Branch to rhomboids.
sps. Suprascapular.
sc. Branch to subclavius.
pt. Posterior thoracic.

Infraclavicular branches :

From outer cord—
cat. External anterior thoracic.
mc. Musculo-cutaneous.
m. Median.

From inner cord—
iat. Internal anterior thoracic.
w. Nerve of Wrisberg.
ic. Internal cutaneous.
u. Ulnar.
m. Median.

From posterior cord—
s 1. Upper.
s 2. Middle.
s 3. Lower subscapular.
c. Circumflex.
ms. Musculo-spiral.

The *outer nerve* crosses over the axillary artery, to the under-surface of the great pectoral muscle in which it ends. On the inner side of the vessel it communicates with the following branch. outer

The *inner nerve* comes forwards between the artery and vein, and after receiving the offset from the outer, ends in many branches to the under-surface of the pectoralis minor. Some twigs enter the great pectoral muscle after passing either through the pectoralis minor or above its border. and inner.

The *subscapular nerves* are three in number, and supply the muscles bounding the axilla behind :— Three subscapular:

The *upper nerve* is the smallest, and enters the upper part of the subscapularis muscle. to subscapularis,

The *middle* or *long subscapular nerve* accompanies the subscapular artery along the posterior wall of the axilla, and supplies the latissimus dorsi muscle (fig. 7). latissimus dorsi,

The *lower subscapular nerve* gives a branch to the lower part of the subscapularis muscle, and ends in the teres major. and teres major.

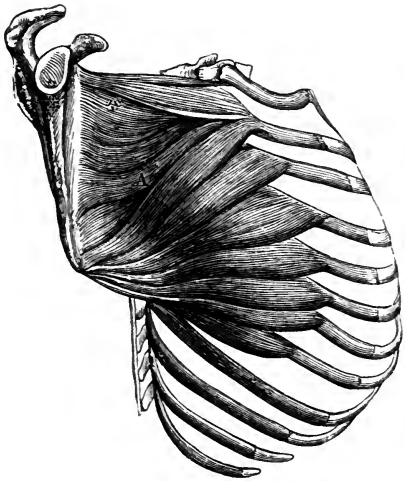


Fig. 9.—The Serratus Magnus.

Another branch of the plexus, the *posterior* or *long thoracic nerve* or *nerve to the serratus*, lies on the inner side of the axilla (fig. 6, 4). It arises above the clavicle from the fifth, sixth, and seventh cervical nerves fig. 8, pt), and descends behind the axillary vessels to reach the outer surface of the serratus magnus muscle. Nerve to serratus.

The LATISSIMUS DORSI MUSCLE (fig. 7) may be examined as far as it enters into the posterior wall of the axilla. Arising from the back of the trunk (p. 7), and crossing the lower angle of the scapula, the muscle ascends to be *inserted* into the bottom of the bicipital groove, by a tendon one inch and a half in width, in front of the teres major ; at the lower border aponeurotic fibres connect the two, but a bursa intervenes between them near the insertion (fig. 17, p. 44). Latissimus dorsi ; insertion.

Dissection. To lay bare the serratus magnus, the arm is to be drawn from the trunk, so as to separate the scapula from the thorax. The nerves of the brachial plexus should be included in a ligature so as to hold them together, and cut through opposite the third rib ; and the fat and connective tissue should be cleaned from the muscular fibres. Dissection of the serratus.

The SERRATUS MAGNUS MUSCLE (fig. 9) extends from the side Serratus magnus :

of the chest to the base of the scapula, and clothes the inner wall
origin; of the axilla. It *arises* from the upper eight or nine ribs by as many slips or digitations, and passes backwards, diminishing in
insertion; breadth, to be *inserted* into the whole length of the base of the scapula on the ventral aspect. From a difference in the arrangement of the slips, the muscle is divided into three parts :—

three parts the muscle; The *upper part* is formed by the first digitation, which is thicker than the others, and springs from the first and second ribs, as well as from a tendinous arch between them : it is inserted into an impression in front of the upper angle of the scapula. The *middle part* is thin, and comprises two digitations, which spread out from the second and third ribs to the vertebral border of the scapula. The *lower part* is the strongest, and consists of the remaining five or six slips, which converge from their ribs (fourth to eighth or ninth) to a special surface on the ventral aspect of the lower angle of the scapula.

relations; The serratus is in great part concealed by the pectoral muscles, the axillary vessels and nerves, and the scapula, with the subscapularis and latissimus dorsi muscles. Its deep surface rests against the ribs and the intercostal muscles. The lower slips interdigitate with like processes of the external oblique muscle.

use. *Action.* The whole muscle acting, the scapula is carried forwards. But the lower part can move forwards the lower angle alone, so as to rotate the bone, and turn the glenoid cavity upwards as in raising the arm above the level of the shoulder. The lowest slips may evert the ribs in forced inspiration.

Removal of the limb. The limb is now to be drawn away from the side of the body and removed by cutting through the serratus magnus muscle about an inch from its insertion into the vertebral border of the scapula, by dividing the omohyoid muscle and the suprascapular vessels and nerves near the upper border of the bone and the latissimus dorsi near the lower angle. The ligatures embracing the axillary vessels and the nerves of the brachial plexus should be fixed to the outer fragment of the clavicle or to the subjacent soft parts, so as to retain them approximately in their position.

Section II.

SCAPULAR MUSCLES, VESSELS, NERVES, AND LIGAMENTS.

Position. *Position.* After the limb has been separated from the trunk it is to be placed with the subscapularis uppermost.

Dissection of muscles. **Dissection.** The different muscles that have been traced to the scapula in the dissection of the front of the chest and of the back are now to be followed to their insertion into the bone. A small part of each, about an inch in length, should be left for the purpose of showing the attachment.

Fig. 10 shows the attachments of the muscles to the ventral surface of the bone, and fig. 12 (p. 32) to the dorsal surface.

Between the larger rhomboid muscle and the serratus magnus, at the base, or vertebral border, of the scapula, run the posterior scapular artery and vein, the ramifications of which are to be traced.

To the borders and the angles of the scapula the following muscles are connected :— Muscles attached

From the *upper margin* of the scapula arises one muscle, the omohyoid (fig. 11, E). About half an inch wide at its origin, the muscle is attached to the edge of the bone behind the notch, and sometimes to the ligament which bridges over the notch. to upper margin of the scapula,

Along the *axillary margin* arise the long head of the triceps (fig. 22, A, p. 51), and the teres minor (H) and major (G) muscles ; to axillary margin,

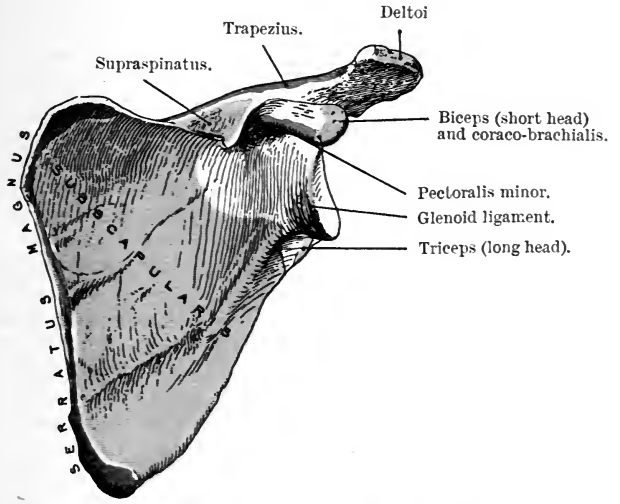


FIG. 10.—THE SCAPULA FROM THE FRONT.

but these attachments will be ascertained in the progress of the dissection.

The *vertebral border* of the bone has four muscles inserted into it. Between the superior angle and the spine is the levator anguli scapulæ (figs. 12 and 13, H) ; opposite the spine the rhomboideus minor (J) is attached ; and between the spine and the inferior angle the rhomboideus major (K) is inserted : the upper fibres of the last muscle often end in an aponeurotic arch, which is fixed to the bone above and below. In front of these muscles, and inserted into the base of the scapula along its whole length, is the serratus magnus muscle (figs. 10 and 11, D), the upper and lower parts of which are much thickened, and occupy special surfaces on the ventral aspect of the corresponding angles of the bone. and to base ;

The insertion of the small pectoral muscle into the anterior half to coracoid process.

of the *coracoid process* at its upper and inner part is also seen (fig. 11, F).

Dissection,

Dissection. By the separation of the serratus from the subscapularis there comes into view a thin fascia, which belongs to the latter muscle, and is fixed to the bone round its margins; after it has been observed, it may be taken away.

In cleaning the muscle, the short, uppermost, subscapular branch, of the posterior cord of the brachial plexus will be found entering its upper part under cover of the axillary vessels, and a branch from the lowest subscapular nerve will be seen to enter its lower, or axillary, border.

nerves of subscapularis.

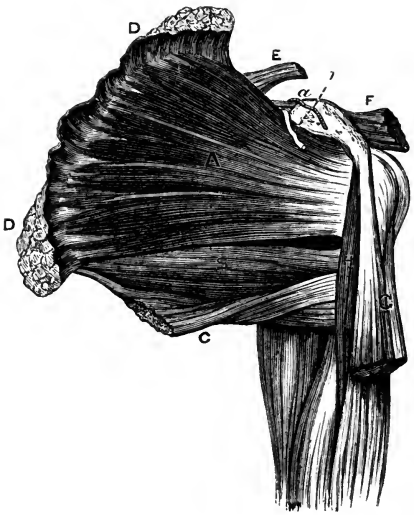


Fig. 11.—View of the Subscapularis and the Surrounding Muscles.

A. Subscapularis.
B. Teres major.
C. Latissimus dorsi.
D. Serratus magnus.
E. Omohyoid.
F. Pectoralis minor.
G. Biceps.
H. Coraco-brachialis.
a. Suprascapular artery.
1. Suprascapular nerve, separated from the artery by the supra-scapular ligament.

Subscapularis:

The subscapularis muscle is to be followed forwards to its insertion into the humerus; and the axillary vessels and nerves, with their offsets to the muscles, should be well cleaned.

The SUBSCAPULARIS MUSCLE (fig 11, A) lies beneath the scapula, and is for the most part concealed by that bone when the limb is in its natural position. It *arises* from the concave ventral surface of the scapula, except near the upper and lower angles, and over the neck; and a thick portion of the muscle is attached in the groove along the axillary margin of the bone: many of the fleshy fibres spring from tendinous septa which are fixed to the ridges on the surface of the scapula (fig. 10). The muscle is *inserted* by a tendon into the impression on the small tuberosity of the humerus, and by fleshy fibres into the bone for nearly an inch below this part (fig. 17).

origin;

insertion;

relations;

By one surface the muscle forms a part of the posterior wall of the axilla, and is in contact with the axillary vessels and nerves, and the serratus magnus. By the other it rests against the scapula and the shoulder-joint; and between its tendon and the root of the coracoid process is a bursa, which generally communicates with the synovial cavity of that joint.

The lower border of the muscle projects beyond the scapula, and

is contiguous to the teres major, the latissimus dorsi, and the long head of the triceps. The subscapular artery runs along this border, and its dorsal branch, as well as the posterior circumflex artery and the circumflex nerve, turn backwards below it.

Action. It rotates the humerus inwards, and when it is raised it depresses that bone. Use.

Dissection. The subscapularis is to be separated from the scapula, except that a thin layer of fibres, in which the vessels lie, is to be left on the bone. As the muscle is raised, its tendinous processes of origin, the connection between its tendon and the capsule of the shoulder-joint, and the bursa are to be observed. A small arterial anastomosis on the ventral surface of the scapula is to be dissected out of the fleshy fibres. Dissection of the

The INFRASCAPULAR ARTERY is an offset of the dorsal branch of the subscapular vessel (p. 24), and ramifies on the ventral surface of the scapula. Passing beneath the subscapular muscle, it forms an anastomosis with small twigs of the suprascapular and posterior scapular arteries. small infrascapular artery.

Position. The examination of the muscles on the dorsal surface of the scapula may be next undertaken. For this purpose the limb is to be turned over; and a block, which is deep enough to make the shoulder prominent, is to be placed between the scapula and the arm. Position of limb.

Dissection. The skin is to be removed from the prominence of the shoulder, down to the middle of the outer side of the arm. After its removal some small cutaneous nerves are to be found in the fat: the upper of these descend over the acromion; and a larger branch comes to the surface about half-way down the posterior border of the deltoid muscle. Dissection of the shoulder.

SUPERFICIAL NERVES. Branches of nerves, *supraacromial*, descend to the surface of the shoulder from the cervical plexus. A *cutaneous branch of the circumflex nerve* (figs. 13 and 23) turns forwards with a small companion artery from beneath the posterior border of the deltoid, and supplies the integuments covering the lower two-thirds of the muscle. Cutaneous nerves.

Dissection. The fat and fascia are now to be taken from the fleshy deltoid, its fibres being made tense for the purpose. Beginning at the anterior edge of the muscle, the dissector is to carry the knife upwards and downwards, following the direction of the coarse muscular fasciculi. As the posterior edge is approached, the cutaneous nerve and vessels escaping from beneath it are to be dissected out. Dissection of deltoid muscle.

At the same time the fascia may be removed from the back of the scapula, so as to denude the muscles there.

The DELTOID MUSCLE (fig. 13 F,) is triangular in form, with the base at the scapula and clavicle, and the apex at the humerus. It *arises* from the whole length of the lower border of the spine of the scapula, the origin being aponeurotic towards the vertebral border of the bone and blending with the dense fascia over the infraspinatus muscle, from the outer edge of the acromion (fig. 12), Deltoid muscle: origin

and from the outer half or third of the front of the clavicle (fig. 5). Its fibres converge to a tendon which is *inserted* into the rough triangular impression on the outer surface of the humerus, above the middle (fig. 17, p. 44).

and insertion;

The anterior border is contiguous to the pectoralis major muscle; and the posterior rests on the infraspinatus, teres, and triceps muscles. The origin of the muscle from the bones of the shoulder corresponds with the insertion of the trapezius. At its insertion the tendon of the deltoid is united with that of the pectoralis major; and a fasciculus of the brachialis anticus is attached to the humerus on each side of it.

adjacent parts.

It consists of three parts,

The middle or *acromial* portion of the deltoid is thicker than the rest, and its fibres form large bundles which run obliquely

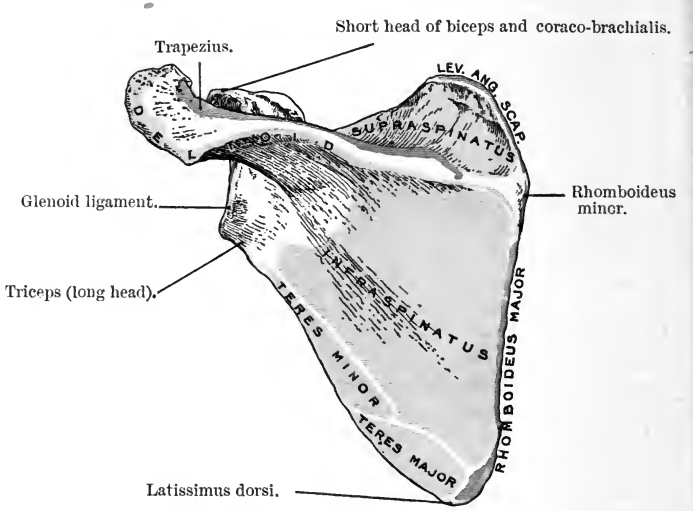


FIG. 12.—THE SCAPULA FROM BEHIND.

between tendinous septa prolonged from the origin and insertion of the muscle. The anterior or *clavicular* and posterior or *spinous* portions are somewhat separate from the foregoing, and their fibres converge to the anterior and posterior edges respectively of the lower tendon.

which have different uses.

Action. The acromial portion of the muscle raises the arm, abducting it from the body; the clavicular part flexes the shoulder-joint, moving the arm forwards and inwards; and the spinous part draws the arm backwards, or extends the shoulder-joint.

Dissection to detach deltoid.

Dissection (fig. 13). The deltoid is to be divided near its origin, and is to be thrown down as far as the circumflex vessels and nerve

Subacromial bursa.

beneath will permit. As the muscle is raised a large thick bursa between it and the upper end of the humerus comes into sight,

and by pulling the arm down from the scapula it will be found to extend beneath the acromion as a large recess. The loose tissue and fat are to be taken away from the circumflex vessels and nerve; and the size of the bursa having been looked to, the remains are to be removed. The insertion of the muscle should be defined.

FIG. 13.—VIEW OF THE MUSCLES OF THE DORSUM OF THE SCAPULA, AND OF THE CIRCUMFLEX VESSELS AND NERVE (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Supraspinatus.
B. Infraspinatus.
C. Teres minor.
D. Teres major.
E. Latissimus dorsi.
F. Deltoid.
G. Triceps (long head).
H. Levator anguli scapulæ.
J. Rhomboideus minor.
K. Rhomboideus major.

Arteries:

a. Posterior circumflex.
b. Branch to teres minor.
c. Dorsal scapular.

Nerves:

1. Circumflex trunk.
2. Its cutaneous offset.
3. Branch to teres minor.

Parts covered by deltoid. The deltoid conceals the upper end of the humerus, and those parts of the dorsal scapular muscles which are fixed to the great tuberosity. Lower down are the circumflex vessels and nerve, and the upper part of the biceps muscle. In front of the humerus is the coracoid process with its muscles. Parts covered by the deltoid.

Dissection. By following back the posterior circumflex vessels and nerve through a space between the humerus and the long head of the triceps (G), their connection with the axillary trunks will be Dissection of posterior circumflex vessels,

arrived at. In clearing the fat from the space a branch of the nerve to the teres minor muscle is to be sought close to the border of the scapula, where it is surrounded by dense fibrous tissue.

and anterior. Arching outwards in front of the humerus is the small anterior circumflex artery, which should also be cleaned.

Two circumflex arteries: The CIRCUMFLEX ARTERIES arise near the termination of the axillary trunk (p. 24); they are two in number, and are named anterior and posterior from their position to the humerus.

anterior; The *anterior branch* (fig. 7, p. 23) is a small artery, which arises from the outer side of the axillary and courses outwards beneath the coraco-brachialis and biceps muscles, and ascends in the bicipital groove to the articulation and the head of the humerus; it anastomoses with small offsets of the posterior circumflex.

posterior, The *posterior circumflex artery* (fig. 13, *a*), much larger than the anterior, winds backwards through a quadrilateral space between the humerus and the long head of the triceps, in company with the circumflex nerve, and ends in large branches, in which it anastomoses with the acromio-thoracic artery.

its offsets. *Branches* are given from it to the shoulder-joint, to the teres minor, the long head of the triceps, and the integuments. It anastomoses with the anterior circumflex artery round the neck of the humerus and with branches of the superior profunda artery in the substance of the triceps.

One circumflex nerve, The CIRCUMFLEX NERVE (fig. 13,[1]) leaves the armpit with the posterior circumflex artery and bends round the humerus, beneath

which ends in deltoid: the deltoid muscle, in which it ends. Many large branches enter the deltoid; and one or two filaments pierce the fore part of the muscle and become cutaneous.

branches, articular; *Branches.* As the nerve passes backwards it gives an *articular* filament to the under-part of the shoulder-joint. Behind the humerus it splits into two parts, an *anterior* and a *posterior*. The

posterior; *posterior part* furnishes (1) a branch to the teres minor, which has a reddish gangliform swelling upon it, (2) a few twigs to the back part of the deltoid, and (3) cutaneous branches which turn round

anterior. the edge of the muscle. The *anterior part* passes round the humerus with the posterior circumflex artery, and enters the fore part of the deltoid muscle, a few twigs passing through the muscle to the skin over it.

Infraspinatus: The INFRASPINATUS MUSCLE (fig. 13, B) occupies the infraspinous fossa of the scapula, and extends to the upper end of the humerus.

origin, The muscle *arises* from the lower surface of the spine of the scapula, from the dorsal surface of the bone below that process, except at the neck and the narrow area along the axillary border where the teres muscles are attached, and from a special fascia covering it. Its

insertion, fibres converge to a tendon, which is inserted into the middle impression on the great tuberosity of the humerus, and joins with the tendons of the supraspinatus and teres minor. The fleshy fibres arising from the spine overlie the tendon of the muscle.

relations, A part of the muscle is subcutaneous; but the upper portion is concealed by the deltoid, and the lower angle by the latissimus

dorsi. The lower border is in contact with the teres minor, with which it is often united. The muscle lies on the scapula and the scapulo-humeral articulation ; and there is sometimes a small bursa between it and the capsule of the joint.

Action. With the humerus hanging it acts as a rotator outwards ; and when the bone is raised it will move the arm backwards in concert with the hinder part of the deltoid. and use.

The TERES MINOR (fig. 13, c) is a narrow fleshy slip, which is often united inseparably with the preceding muscle. It *arises* on the dorsum of the scapula from a special impression along the upper two-thirds of the axillary border of the bone, and from an intermuscular septum on each side ; and it is *inserted* by a tendon into the lowest of the three marks on the great tuberosity of the humerus, as well as by fleshy fibres into the bone below that spot, about an inch altogether. Teres minor; origin, insertion,

This muscle is partly covered by the deltoid ; it rests on the long head of the triceps and the shoulder-joint. Underneath it the dorsal branch of the subscapular artery turns on to the back of the scapula. parts around it,

Action. The limb hanging, the muscle rotates it out and moves it back ; the arm being raised, the teres depresses the humerus. and use.

The TERES MAJOR MUSCLE (fig. 13, D) passes from the inferior angle of the scapula to the humerus. Its *origin* is from an oval surface behind the inferior angle of the scapula, from the lower half of the axillary border of the bone, and from the intermuscular septum between it and the teres minor. The fibres end in a tendon which is *inserted* into the inner edge of the bicipital groove of the humerus. Teres major: origin ; insertion;

The muscle assists in forming the posterior fold of the axilla, and is situate beneath the axillary vessels and nerves near the humerus (fig. 4). The upper border is contiguous to the subscapularis muscle, and the lower is received into a hollow formed by the latissimus dorsi, which covers the teres behind at its origin, and in front at its insertion. At the humerus the tendon of the muscle is about two inches wide, and is placed behind that of the latissimus : the two are separated above by a bursa ; but they are united below, and an expansion is sent from them to the fascia of the arm. A second bursa is frequently present between the teres and the bone. relations ;

Action. If the limb hangs, it is carried back behind the trunk, and is rotated inwards by the muscle. The humerus being raised, the muscle depresses and adducts it. use on swinging

With the limb fixed by the hand the teres will cause the lower angle of the scapula to move forwards. and fixed limb.

Below the scapula, where the teres muscles separate from one another, is a triangular interval, which is bounded in front by the shaft of the humerus, and above and below by the teres minor and major (fig. 13). The space is divided into two by the long head of the triceps. Through the anterior part, which is of a quadrilateral shape, the posterior circumflex vessels (*a*) and the circumflex Triangular space. Quadrilateral space.

nerve (1) pass; and opposite the posterior triangular space the dorsal branch (*c*) of the subscapular artery bends backwards.

Dissection

Dissection (fig. 14). The ligaments of the scapula and clavicle should be examined.

of ligaments of the clavicle,

A strong ligament (coraco-clavicular) ascends from the coracoid process to the under-part of the clavicle. On removing the areolar tissue it will be seen to consist of two parts, anterior and posterior, differing in size, and in the direction of the fibres.

A capsular ligament, connecting the outer end of the clavicle with the acromion, will be shown by taking away the fibres of the trapezius and deltoid muscles.

and of scapula.

Another strong band (coraco-acromial) passing transversely between the acromion and the coracoid process, and a small

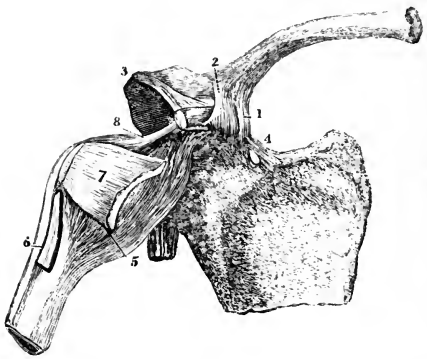


FIG. 14.—LIGAMENTS OF THE CLAVICLE AND SCAPULA, AND OF THE SHOULDER-JOINT (ALTERED FROM BOURGERY).

1. Conoid ligament.
2. Trapezoid ligament.
3. Coraco-acromial ligament.
4. Suprascapular ligament.
5. Capsule of shoulder-joint.
6. Tendon of long head of biceps, entering the joint.
7. Tendon of subscapularis muscle.
8. Coraco-humeral ligament.

fasciculus (suprascapular ligament), placed over the notch in the superior border, are then to be defined.

Union of the clavicle and scapula.

LIGAMENTS OF THE CLAVICLE AND SCAPULA (fig. 14). The outer end of the clavicle forms a synovial joint with the acromion, and is united to the coracoid process by a strong coraco-clavicular ligament.

Coraco-clavicular has

The CORACO-CLAVICULAR LIGAMENT consists of two portions, each having a different direction and designation.

a conical

The posterior piece (1), called *conoid* from its shape, is fixed by its apex to the posterior and inner part of the coracoid process, and by its base to the tubercle of the clavicle, at the junction of the outer with the middle third of the bone.

and a square piece

The anterior part (2) *trapezoid ligament*, is larger than the conoid; it is attached below to the inner border of the coracoid process along

the hinder half, and above to the line on the under-surface of the clavicle, which extends outwards from the tubercle before mentioned. The two pieces of the ligament are in apposition behind, but are usually separated by an interval in front.

Use. Both pieces of the ligament support the scapula in a state of rest. They serve also to restrain the rotatory movements of that bone; thus, when the acromion is rotated down, the motion is checked by the trapezoid band, and when upwards by the conoid piece. Use of ligament.

ACROMIO-CLAVICULAR ARTICULATION. The articular surfaces of the clavicle and acromion process of the scapula are connected together by a *capsule*, which is thick above (superior ligament), but very thin below. Joint with acromion: capsule,

An *interarticular fibro-cartilage* is sometimes present at the upper part of the joint; and occasionally it forms a complete septum. If the fibro-cartilage is perfect, there are two *synovial cavities* in the joint; if it is imperfect, there is only one. The joint should be opened to see the cartilage and the synovial sac. fibro-cartilage, and synovial sac.

Movements. This articulation allows the scapula to change its position in relation to the clavicle when the former bone is moved, either in gliding over the surface of the thorax, or in being rotated with the elevation and depression of the arm. Use of joint.

SCAPULAR LIGAMENTS. The *special ligaments* of the scapula are two in number, and extend from one point of the bone to another. Ligaments of scapula:

1. The SUPRASCAPULAR LIGAMENT (4) is a narrow band stretching across the notch in the upper border of the bone. By one end it is attached to the base of the coracoid process, and by the other to the border behind the notch. It converts the notch into a foramen, through which the suprascapular nerve passes. supra-scapular;

2. The CORACO-ACROMIAL LIGAMENT (3) is triangular in form, and extends transversely between the acromion and the coracoid process. Externally it is inserted by its apex into the tip of the acromion; and internally, where it is much wider, it is attached to all the outer border of the coracoid process, reaching backwards to the capsule of the shoulder-joint. The ligament consists usually of two thickened bands, anterior and posterior, with a thinner intervening part. It forms part of an arch above the shoulder-joint, which prevents the head of the humerus being displaced upwards. coraco-acromial, formed of two pieces: use.

Dissection. The supraspinatus muscle should now be laid bare, the acromion process sawn through, and turned aside with the outer end of the clavicle. A strong fascia will be seen to cover the surface of the supraspinatus muscle, and is to be taken away after it has been observed. Dissection.

The SUPRASPINATUS MUSCLE (fig. 13, A) has the same form as the hollow of the bone which it fills. It *arises* from the surface of the supraspinous fossa of the scapula, except over the neck, from the upper side of the spine of the bone, and from the fascia covering its surface. Its fibres end in a tendon, which crosses over the shoulder-joint, and is *inserted* into the upper impression on the great tuberosity of the humerus. Supraspinatus: origin; insertion;

relations ; The muscle is concealed by the trapezius and the acromion process ; and it rests upon the scapula, the suprascapular vessels and nerve, and the shoulder-joint. Its tendon joins that of the infraspinatus at the attachment to the humerus.

use. *Action.* It comes into use with the acromial portion of the deltoid in raising the limb and supporting the joint.

Dissection of suprascapular vessels. **Dissection** (fig. 22, p. 52). The vessels and nerves on the dorsum of the scapula can be traced by detaching from behind forwards the supraspinatus and infraspinatus muscles, so as to leave a thin layer of the fleshy fibres with the ramifying blood-vessels on the surface of the bone. In the supraspinous fossa are the suprascapular vessels and nerve, which are to be followed beneath the acromion to the infraspinous fossa ; and entering the infraspinous fossa, beneath the teres minor muscle, is the dorsal branch of the subscapular artery. The anastomosis between these vessels should be pursued in the fleshy fibres and cleaned.

Suprascapular artery The SUPRASCAPULAR ARTERY (*a*) is derived from the thyroid axis of the subclavian trunk (p. 9). After a short course in the neck it crosses over the suprascapular ligament, and passing beneath the

ends in infraspinatus and supraspinatus muscle, ends in the infraspinous fossa, where it gives offsets to the infraspinatus muscle and the scapula, and anastomoses with the dorsal branch of the subscapular artery and the posterior scapular of the subclavian.

subscapular and supraspinous offsets. Before entering the supraspinous fossa, it gives a small branch to the ventral surface of the scapula ; and beneath the supraspinatus it furnishes offsets to that muscle, the bone, and the shoulder-joint.

Vein. The companion *vein* of the suprascapular artery joins the external jugular vein.

Suprascapular nerve : The SUPRASCAPULAR NERVE ([1]) is a branch of the brachial plexus (5th and 6th cervical nerves ; fig. 8, sps., p. 26). At the upper border of the scapula, it enters the supraspinous fossa beneath the

branches, muscular suprascapular ligament. In the fossa it supplies two branches to the supraspinatus ; and it is continued beneath a fibrous band to the infraspinatus muscle, in which it ends.

and articular. The nerve gives some *articular* filaments to the shoulder-joint, and other offsets to the scapula.

Posterior scapular artery. The POSTERIOR SCAPULAR ARTERY runs along the base of the scapula beneath the rhomboid muscles, furnishing offsets to them and to the surfaces of the bone. It has been more fully noticed with the dissection of the back (p. 9).

Dorsal scapular artery. The DORSAL SCAPULAR ARTERY (*b*) is a branch of the subscapular (p. 24), and, after giving off its infrascapular offset, turns round the axillary border of the bone opposite the posterior of the two spaces between the teres muscles. Entering the infraspinous fossa beneath the teres minor, it supplies that muscle and the infraspinatus, and anastomoses with the suprascapular and posterior scapular arteries. It sends a considerable branch downwards between the teres muscles, towards the lower angle of the bone.

Section III.

THE FRONT OF THE ARM.

Position. For the dissection of the superficial vessels and nerves on the front of the arm the limb should lie flat on the table, with the anterior surface uppermost. Position,

Dissection. The skin is to be raised from the fore and lateral surfaces of the arm and elbow. One incision should be made along the centre of the limb as far as two inches below the bend of the elbow, and at the termination of this a second cut half round the forearm. Strip the skin from the limb as low as the transverse incision, leaving the fat and the cutaneous vessels and nerves behind. For special dissections of the parts in front of the bend of the elbow the incisions (13, 14, 15) and incisions in the skin.

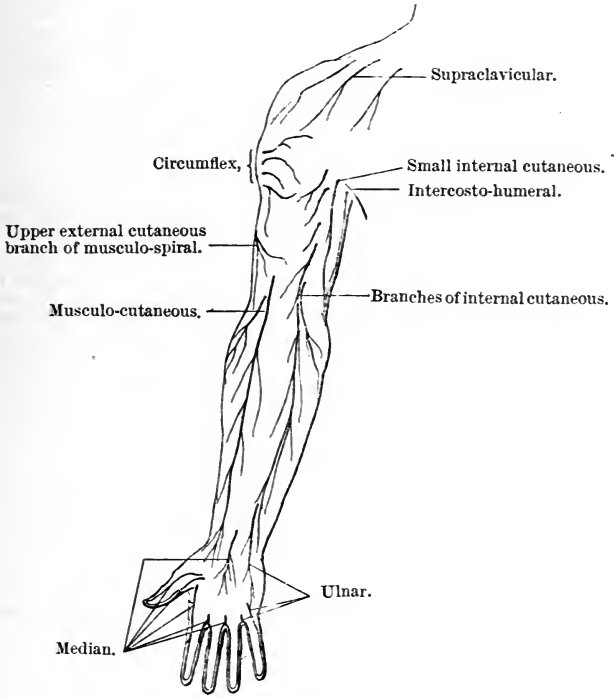


Fig. 15.—Diagram of Cutaneous Nerves of Front of Arm.

shown on fig. 1, B, should be used. The skin will thus remain hinged along a narrow attachment running down the middle of the back of the arm, from which it can be used to cover the part.

Seek superficial veins.

The cutaneous veins (fig. 16) should be first sought for in the fat. They are very numerous below the bend of the elbow, as they issue from beneath the integument. In the centre of the forearm is the *median vein*, which bifurcates rather below the elbow, sending branches to either side. On the outer side is

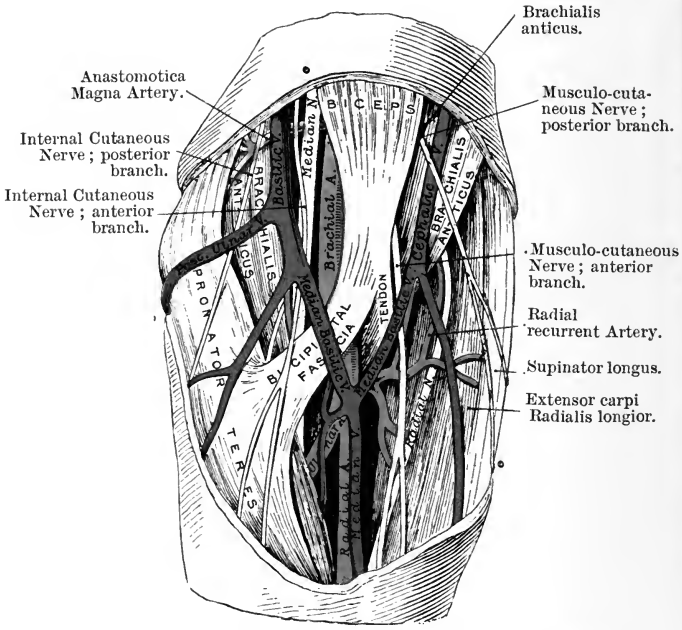


Fig. 16.—Dissection of the Front of the Elbow (After Morris).

the *radial vein ;* and internally are the *anterior* and *posterior ulnar veins*, coming from the front and back of the forearm. At the elbow the veins are united into two stems, one (basilic) passing upwards along the inner side, and the other (cephalic) along the outer side of the arm.

Trace cutaneous nerves

The cutaneous nerves are next to be traced out. Where they perforate the deep fascia they lie beneath the fat ; and this layer must be scraped through to find them.

of outer side

On the outer side of the arm, about the middle, two external *cutaneous branches of the musculo-spiral* are to be sought. In the outer bicipital groove, in front of the elbow or rather below it, the

cutaneous part of the *musculo-cutaneous nerve* will be recognised. See fig. 16.

On the inner part of the limb the nerves to the surface are more numerous. Taking the basilic vein as a guide, the *internal cutaneous nerve* of the forearm will be found by its side, about the middle of the arm; and a little external to this nerve is a small cutaneous offset from it, which pierces the fascia higher up. Finally follow down the small nerves which have been already met with in the dissection of the axilla, viz., the *intercosto-humeral*, the lesser internal cutaneous (nerve of Wrisberg), and the internal cutaneous of the musculo-spiral. and inner side of the limb.

Superficial fascia. The subcutaneous fatty layer forms a continuous investment for the limb, but it is thicker in front of the elbow than in the other parts of the arm. At that spot it encloses the superficial vessels and lymphatics. Superficial fat.

CUTANEOUS VEINS. The position and relations of the veins in front of the elbow are to be attentively noted by the dissector, because the operation of venesection is practised on one of them (fig. 16). Superficial veins.

The MEDIAN VEIN of the forearm divides into two branches, internal and external, rather below the bend of the elbow; and at its point of division it is joined by an offset from a deep vein. The internal branch (*median-basilic*) crosses to the inner border of the biceps, and unites with the ulnar veins to form the basilic vein of the inner side of the arm. The external branch (*median-cephalic*) is usually longer than the other, and by its junction with the radial vein gives rise to the cephalic vein of the arm. Median vein, two branches:

The MEDIAN-CEPHALIC VEIN is directed obliquely, and lies over the hollow between the biceps and the outer mass of muscles of the forearm; beneath it is the trunk of the musculo-cutaneous nerve. This vein is altogether removed from the brachial artery, and is usually smaller than the median-basilic vein. If opened with a lancet it does not generally yield much blood, in consequence of its position in a hollow between muscles rendering compression of it very uncertain and difficult. median-cephalic;

The MEDIAN-BASILIC VEIN is more transverse in direction, and larger than the preceding; and it crosses the brachial artery. It is firmly supported by the underlying fascia, the aponeurosis of the arm, strengthened by an offset from the biceps tendon, intervening between it and the brachial vessels. Branches of the internal cutaneous nerve lie beneath it, and some twigs of the same nerve are placed over it. median-basilic.

The median-basilic is the vein on which the operation of blood-letting is commonly performed. It is selected in consequence of its usually larger size, and more superficial position, and of the ease with which it may be compressed; but, from its close proximity to the brachial vessels, the spot to be opened should not be immediately over the trunk of the artery. Venesection.

The BASILIC VEIN, commencing as before said, ascends near Basilic vein.

the inner border of the biceps muscle to the middle of the arm, where it passes beneath the deep fascia, and is continued into the axillary vein. In this course it lies to the inner side of the brachial artery.

Cephalic vein.

The CEPHALIC VEIN is derived chiefly from the external branch of the median, for the radial vein is oftentimes very small; it is continued to the shoulder along the outer side of the biceps, and sinks between the deltoid and pectoral muscles to open into the axillary vein near the clavicle.

Superficial lymphatics

The *superficial lymphatics* of the arm lie for the most part along the basilic vein, and enter the glands of the axilla. A few lymphatics accompany the cephalic vein, and end in the upper axillary glands.

and glands.

One or more superficial lymphatic glands are commonly found a little above the inner condyle of the humerus.

Superficial nerves.

CUTANEOUS NERVES (fig. 15). The superficial nerves of the arm appear on the inner and outer sides, and spread so as to cover the surface of the limb. With one exception (intercosto-humeral), all are derived from the brachial plexus, either as distinct branches, or as offsets of other nerves. On the outer side of the limb are branches of the musculo-spiral and musculo-cutaneous nerves. On the inner side are two internal cutaneous nerves from the plexus, a third internal cutaneous from the musculo-spiral, and the intercosto-humeral nerve.

External cutaneous nerves:

The EXTERNAL CUTANEOUS BRANCHES OF THE MUSCULO-SPIRAL NERVE are two in number, and appear at the outer side of the limb about the middle.

two from musculo-spiral;

The *upper* small one turns forwards with the cephalic vein, and reaches the front of the elbow, supplying the anterior part of the arm. The *lower* and larger pierces the fascia somewhat farther down, and, after supplying some cutaneous filaments to the back of the arm, is continued to the forearm.

and musculo-cutaneous.

The MUSCULO-CUTANEOUS NERVE pierces the fascia in front of the elbow; it lies beneath the median-cephalic vein, and divides into branches for the forearm.

Internal cutaneous nerves,

The INTERNAL CUTANEOUS NERVE perforates the fascia in two pieces, or as one trunk that divides almost directly into two. Its anterior branch passes beneath the median-basilic vein to the front

large

of the forearm; and the posterior winds over the inner condyle of the humerus to the back of the forearm.

A slender offset of the nerve pierces the fascia near the axilla, and reaches as far, or nearly as far, as the elbow; it supplies the integuments over the biceps muscle.

and small;

The NERVE OF WRISBERG (small internal cutaneous) appears behind the preceding, and extends to the interval between the olecranon and the inner condyle of the humerus, where it ends in filaments over the back of the olecranon. The nerve gives offsets to the lower third of the arm on the inner and posterior surfaces, and joins above the elbow the posterior branch of the larger internal cutaneous nerve.

The INTERNAL CUTANEOUS BRANCH OF THE MUSCULO-SPIRAL NERVE, becoming subcutaneous in the upper third, winds to the back of the arm, and reaches nearly as far as the olecranon. one from musculo-spiral;

The INTERCOSTO-HUMERAL NERVE, a branch of the second intercostal (p. 13, and fig. 4), perforates the fascia near the axilla, and ramifies on the inner side and posterior surface of the arm in the upper half. The size and distribution of this nerve depend upon the development of the small internal cutaneous and the offset of the musculo-spiral. and intercosto-humeral.

The DEEP FASCIA of the arm is a white shining membrane, which surrounds the limb, and sends processes between the muscles. Over the biceps muscle it is thinner than elsewhere. At certain points it receives accessory fibres from the subjacent tendons: thus, in front of the elbow an offset from the tendon of the biceps joins it; and near the axilla the tendons of the pectoralis major, latissimus dorsi, and teres major send prolongations to it. Aponeurosis of the arm — receives accessions from tendons;

At the upper part of the limb the fascia is continuous with that of the axilla, and is prolonged over the deltoid and pectoral muscles to the scapula, clavicle, and chest. Below, it is continued to the forearm, and is connected to the prominences of bone around the elbow-joint, especially to the supracondylar ridges of the humerus, so as to give rise to the intermuscular septa of the arm. disposition above, — and below; — forms intermuscular septa.

Dissection. The muscles and vessels of the arm will next be dissected; the limb is still to lie on the back, but the shoulder is to be raised by means of a small block; and the scapula is to be fixed in such a position as to render tense the muscles. The inner surface of the arm is to be placed towards the dissector.

The aponeurosis is to be reflected from the front of the arm by an incision along the centre, like that through the skin; and it is to be removed on the outer side as far as the outer supracondylar ridge of the humerus, but on the inner side rather farther back than the corresponding line, so as to lay bare part of the triceps muscle. In raising the fascia the knife must be carried in the direction of the fibres of the biceps muscle; and, to prevent the displacement of the brachial artery and its companion nerves, fasten them here and there with stitches. Dissection of muscles, — of vessels,

In front of the elbow is a hollow containing the brachial vessels; and into this the artery should be followed, to show its ending in the radial and ulnar trunks. and of hollow of elbow.

MUSCLES ON THE FRONT OF THE ARM. There are only three muscles on the front of the arm. The one along the centre of the limb is the biceps; and that along its inner side, reaching about half-way down, is the coraco-brachialis. The brachialis anticus lies beneath the biceps. Some muscles of the forearm are connected to the inner and outer condyles of the humerus, and to the ridge above the outer condyle. Position of the muscles of the arm.

The BICEPS MUSCLE (fig. 18, p. 45, and fig. 7, p. 23) forms the prominence seen on the front of the arm. It is wider at the middle than at either end; and the upper end consists of two tendinous pieces of different lengths, which are attached to the Biceps flexor brachii:

origin from the scapula; scapula. The *short head* is the innermost, and *arises* from the tip of the coracoid process in common with the coraco-brachialis muscle (fig. 10, p. 29); and the *long head* is attached just above the glenoid fossa of the scapula, within the capsule of the shoulder-joint and is connected with the glenoid ligament on either side of the fossa. Muscular fibres spring from each tendinous head, and meet to form a fleshy belly, which is somewhat flattened from before back.

insertion into radius; Inferiorly the biceps ends in a tendon, which is *inserted* into the tuberosity of the radius (fig. 25, p. 61), having previously given off a slip to the fascia in front of the elbow.

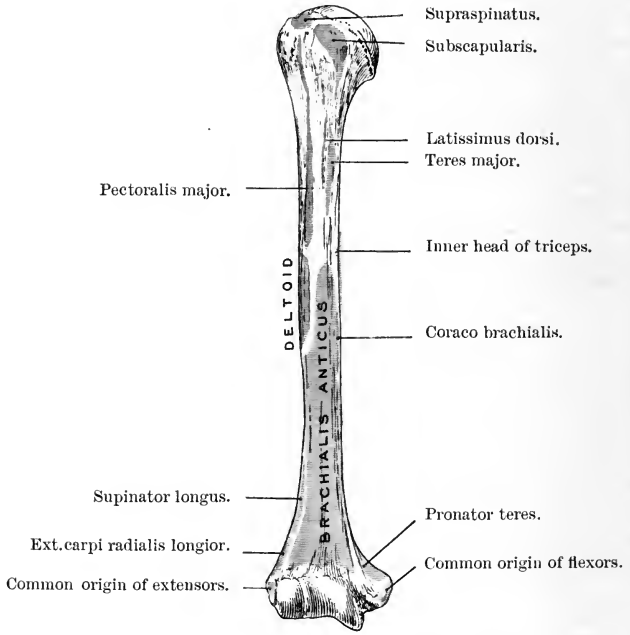


FIG. 17.—THE HUMERUS FROM THE FRONT.

parts covering The muscle is superficial except at the extremities. At the upper part it is concealed by the pectoralis major and deltoid muscles; and at the lower end the tendon dips into the hollow in

and beneath it; front of the elbow. Beneath the biceps are the musculo-cutaneous nerve, the upper part of the humerus, and the brachialis anticus

inner border is guide to the artery; muscle. Its inner border is the guide to the brachial artery below the middle of the humerus, but above that spot the coraco-brachialis muscle intervenes between them. The connection of the long head of the biceps with the shoulder-joint and the insertion of the muscle into the radius will be afterwards learnt.

use on radius, *Action.* It bends the elbow-joint, and acts powerfully in

supinating the radius. When the body is hanging by the hands it will apply the scapula firmly to the humerus, and will assist in raising the trunk.

With the arm hanging and the radius fixed, the long head will assist the abductors in removing the limb from the side; and, after the limb is abducted, the short head will aid in restoring it to the pendent position.

The CORACO-BRACHIALIS is partly concealed by the biceps, and extends to the middle of the arm. Its *origin* is fleshy from the tip of the coracoid process (fig. 10), and from the tendinous short head of the biceps. Its fibres become tendinous below, and are *inserted* into a narrow mark on the inner side of the humerus, below the level of the deltoid (fig. 17). Some of the fibres frequently end on an aponeurotic arch, which extends from the upper end of the humerus to the insertion of the muscle.

The upper half of this muscle is beneath the pectoralis major (fig. 20, p. 49); and its inner part projects beyond the short head of the biceps, forming a prominence in the axilla. Its insertion is covered by the brachial vessels and the median nerve. The coraco-brachialis lies over the subscapular muscle, the

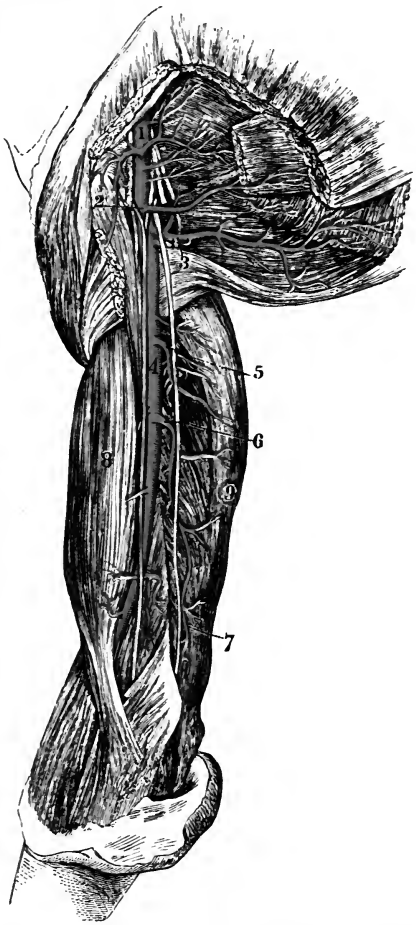


FIG. 18.—AXILLARY AND BRACHIAL ARTERIES (QUAIN'S "ARTERIES").

1. Axillary artery and branches. The small branch above the figure is the superior thoracic, and the larger branch close below the acromio-thoracic.
2. Long thoracic.
3. Subscapular.
4. Brachial artery.
5. Superior profunda branch.
6. Inferior profunda.
7. Anastomotic.
8. Biceps muscle.
9. Triceps muscle.

The median and ulnar nerves are shown in the arm; the median is close to the brachial artery.

and the trunk,

on humerus.

Coraco-brachialis:

origin;

insertion;

relations;

anterior circumflex vessels, and the tendons of the latissimus dorsi and teres major. Along the inner border are the large artery and nerves of the limb; and the musculo-cutaneous nerve perforates it.

use on limb. *Action.* The coraco-brachialis moves forwards the arm, and adducts it to the thorax.

Brachial artery extends to elbow: The BRACHIAL ARTERY (fig. 18,[4]) is a continuation of the axillary

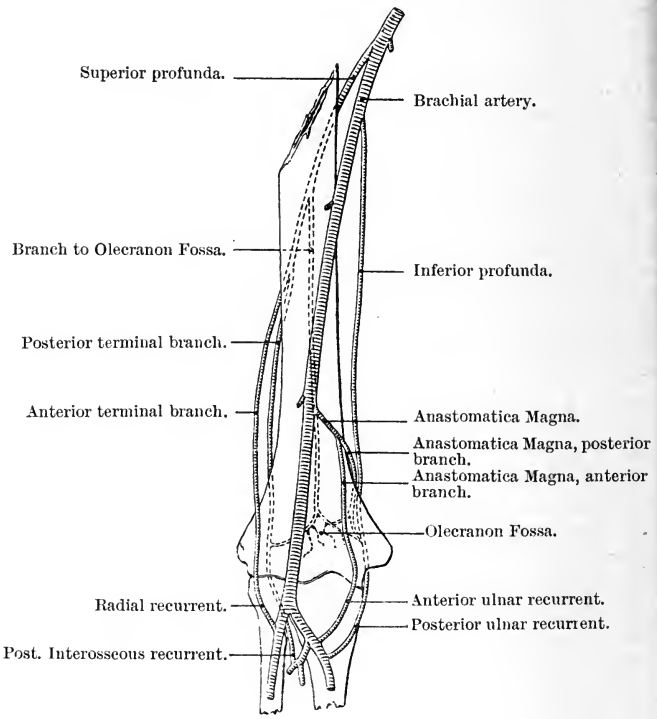


FIG. 19.—ANASTOMOSIS ABOUT THE ELBOW JOINT.

trunk, and supplies vessels to the upper limb. It begins at the lower border of the teres major muscle, and terminates rather below the bend of the elbow, or opposite the neck of the radius, in two branches, radial and ulnar, for the forearm.

position to bone, and in the limb; The vessel is internal to the humerus in the upper part of its course, but in front of the bone below the middle of the arm; and its situation is indicated by the surface depression along the inner border of the biceps and coraco-brachialis muscles.

relations with fasciæ Throughout the arm the brachial artery is superficial, being

covered only by the integuments and the deep fascia; but at the bend of the elbow it becomes deeper, and is crossed by the prolongation from the tendon of the biceps. Posteriorly the artery has the following muscular connections (fig. 20, p. 49):—While it is inside the humerus it is placed over the long head of the triceps (F) for two inches, but separated partly by the musculo-spiral nerve and profunda vessels, and over the inner head (G) of the same muscle for about an inch and a half. But when the vessel passes to the front of the bone it lies on the insertion of the coraco-brachialis (C) and on the brachialis anticus (H). To the outer side are the coraco-brachialis and biceps muscles (C and B), the latter overlapping it. and muscles,

Veins. Venæ comites lie along the sides of the artery (fig. 20, *d*), encircling it with cross branches, and the median-basilic vein crosses over it at the elbow. The basilic vein is near the artery, on the inner side, above; but it is superficial to the fascia in the lower half of the arm. with veins,

The *nerves* in relation with the artery are the following:— The internal cutaneous (fig. 20, [2]) is in contact with the vessel until it perforates the fascia about the middle of the arm. The ulnar nerve ([4]) lies to the inner side as far as the insertion of the coraco-brachialis muscle; and the musculo-spiral is behind for a distance of two inches. The median nerve (fig. 20, [1]) is close to the vessel throughout, but alters its position in this way:— as low as the insertion of the coraco-brachialis it is placed on the outer side, but it then crosses obliquely over, or occasionally under, the artery, and becomes internal about two inches above the elbow-joint. and with four nerves.

Unusual position. The brachial trunk occasionally leaves the inner border of the biceps in the lower half of the arm, and courses along the intermuscular septum, with or without the median nerve, to near the inner condyle of the humerus. At this spot the vessel is directed to its ordinary position in front of the elbow, beneath the upper fibres of the pronator teres, which has then a wide origin. In this unusual course the artery lies behind a projection (supracondylar process) of the humerus. Deviation in position;

Muscular covering. In some bodies the brachial artery is covered by an additional slip of origin of the biceps, or of the brachialis anticus muscle. And sometimes a slip of the brachialis may conceal, in cases of high origin of the radial, the remainder of the arterial trunk continuing to the forearm. in muscular covering.

High division. Instead of a single trunk, there may be two vessels in the lower part, or even the whole length of the arm, owing to an unusually high origin of one of the arteries of the forearm, more frequently the radial. Artery double.

Vasa aberrantia. Occasionally a long slender vessel passes from the brachial or the axillary trunk to the radial, rarely to the ulnar artery. Aberrant vessels.

Branches spring both externally and internally from the brachial artery (fig. 18). Those on the outer side, *muscular*, supply the coraco-brachialis, biceps, and brachialis anticus, as well as the lower part of the deltoid; those on the inner side are the superior and inferior profunda, the medullary artery of the humerus, Its branches are muscular,

and the anastomotic branch. The superior and inferior profunda and the anastomotic branches of the brachial form a free anastomosis about the elbow-joint with various arteries of the forearm, and the accompanying scheme (fig. 19) represents the general arrangement.

superior profunda,

The *superior profunda branch* (5) is larger than the others, and leaves the artery near the lower border of the teres major ; it winds backwards with the musculo-spiral nerve to the triceps muscle, and will be dissected with the back of the arm (p. 53).

inferior profunda,

The *inferior profunda branch* (6) arises opposite the coraco-brachialis muscle, and accompanies the ulnar nerve to the interval between the olecranon and the inner condyle of the humerus. There it anastomoses with the posterior ulnar recurrent and anastomotic branches, and supplies the triceps. It often arises in common with the superior profunda artery.

artery to bone,

The *medullary artery of the humerus* arises near the inferior profunda, generally associated with various muscular branches, and enters the aperture about the middle of the humerus, being directed downwards.

and anastomotic.

The *anastomotic branch* (7) arises one or two inches above the elbow, and its main branch courses inwards through the intermuscular septum to the hollow between the olecranon and the inner condyle of the humerus. Here the artery anastomoses with the inferior profunda and posterior ulnar recurrent branches, and gives twigs to the triceps muscle ; one of the offsets forms an arch across the back of the humerus with a branch of the superior profunda.

Before passing through the intermuscular system the artery sends an offset to the pronator teres muscle in front of the internal condyle, which joins the anterior ulnar recurrent vessel.

Veins end in the axillary.

The BRACHIAL VEINS (fig. 20, *d*) accompany the artery, one on each side, and have branches of communication across that vessel ; they receive tributary veins corresponding to the branches of the artery. Above, they usually join into one, which enters the axillary vein near the subscapular muscle.

Nerves on front of arm.

NERVES OF THE ARM (fig. 20). The nerves on the front of the arm are derived from the terminal cords of the brachial plexus. They furnish but few offsets above the elbow, being for the most part continued to the forearm and the hand. The cutaneous branches of some of them have been already referred to (p. 42).

Median nerve with the artery

The MEDIAN NERVE (1) arises from the brachial plexus by two heads, one from the outer, and the other from the inner cord (fig. 7, p. 23), and accompanies the brachial artery to the forearm. Beginning on the outer side of the artery, the nerve crosses over (sometimes under) it near the middle of the arm, and is placed on

has not any branch.

the inner side a little above the elbow. It does not give any branch in the arm ; but there may be a fasciculus connecting it with the musculo-cutaneous nerve. Its relations to muscles are the same as those of the artery.

The ULNAR NERVE (4), derived from the inner cord of the brachial plexus, lies close to the inner side at first of the axillary, and then of the brachial artery as far as the insertion of the coraco-brachialis; then leaving the blood-vessel, it is directed backwards through the inner intermuscular septum to the interval between the olecranon and the internal condyle, being surrounded by the muscular fibres of the triceps. There is not any branch from the nerve till it reaches the elbow-joint. Ulnar nerve is without branch as far as the elbow.

The INTERNAL CUTANEOUS (2) is mainly distributed in the forearm. Arising from the inner cord of the plexus, it is at first superficial to the brachial artery as far as the middle of the arm, Internal cutaneous nerve beneath the fascia.

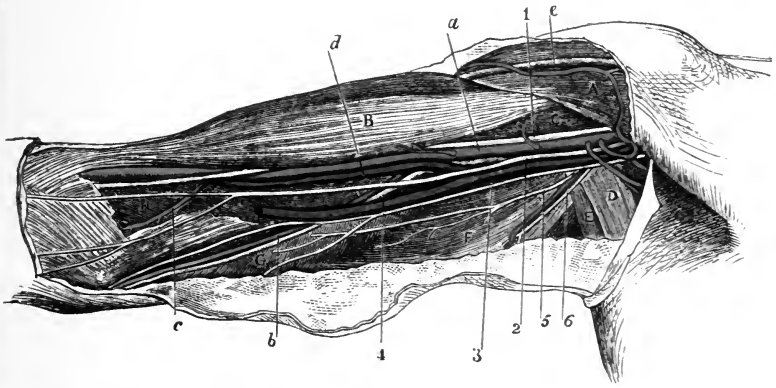


FIG. 20.—DISSECTION OF THE INNER SIDE OF THE ARM (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Pectoralis major.
B. Biceps.
C. Coraco-brachialis.
D and E. Latissimus and teres.
F. Long head of triceps.
G. Inner head of triceps.
H. Brachialis anticus.

Vessels:

a. Brachial artery.
b. Inferior profunda.
c. Anastomotic.
d. Internal vena comes, joining the basilic vein a little above the middle of the arm.

Nerves:

1. Median.
2. Internal cutaneous.
3. Nerve of Wrisberg.
4. Ulnar.
5. Muscular to the triceps.
6. Internal cutaneous from the musculo-spiral.

where it divides into two branches that perforate the investing fascia and reach the forearm. Near the axilla it furnishes a small offset to the skin of the front of the arm.

The NERVE OF WRISBERG (small internal cutaneous 3) arises with the preceding. Concealed at first by the axillary vein, it is directed inwards beneath (but sometimes through) that vein, and joins with the intercosto-humeral nerve. Afterwards it lies along the inner part of the arm as far as the middle, where it perforates the fascia to end in the integument. Nerve of Wrisberg beneath the fascia.

Musculo-cutaneous nerve in the arm :

The MUSCULO-CUTANEOUS NERVE, named from supplying muscles and integuments, ends on the surface of the forearm. It leaves the outer cord of the brachial plexus opposite the lower border of the pectoralis minor, and immediately perforates the coraco-brachialis ; it is then directed obliquely to the outer side of the limb beneath the biceps and lying upon the brachialis anticus. At the front of the elbow it becomes a cutaneous nerve of the forearm.

its muscular branches.

Branches. The nerve furnishes a branch to the coraco-brachialis before entering the muscle, and others to the biceps and brachialis anticus where it is placed between them.

Dissection.

Dissection. The brachialis anticus muscle will now be brought into view by cutting through the tendon of the biceps near the elbow, and turning upwards this muscle. The fascia and areolar tissue should be taken from the fleshy fibres ; and the lateral extent

Define brachialis.

of the muscle should be defined on each side, so as to show that it reaches the intermuscular septum largely on the inner side, but only for a short distance above on the outer side.

Some care is required in detaching the brachialis on the outer side from the muscles of the forearm, to which it is closely applied. As the muscles are separated, the musculo-spiral nerve, accompanied by a small branch of the superior profunda artery, comes into sight.

Brachialis anticus : origin ;

The BRACHIALIS ANTICUS (fig. 20, H) covers the elbow-joint and the lower half of the front of the humerus. It *arises* from the anterior surface of the humerus below the insertion of the deltoid muscle, and from the intermuscular septa on the sides, viz., from all the inner, but from only the upper part of the outer (fig. 17,

insertion ;

p. 44). The fleshy fibres converge to a tendon, which is *inserted* into the impression on the front of the coronoid process of the ulna (fig. 25, p. 61).

relations of surfaces,

This muscle is for the most part concealed by the biceps. On it lie the brachial vessels, with the median, musculo-cutaneous, and musculo-spiral nerves. It covers the humerus and the articulation of the elbow. Its origin embraces by two slips the tendon of the deltoid ; and its insertion is placed between two fleshy points of the

of borders ;

flexor profundus digitorum. The inner border reaches the intermuscular septum in all its length ; but the outer is separated below from the external intermuscular septum by two muscles of the forearm, supinator longus and extensor carpi radialis longior.

use, forearm free,

Action. The brachialis brings forward the ulna towards the humerus, and bends the elbow-joint.

and fixed.

If the ulna is fixed, as in climbing with the hands above the head, the muscle bends the joint by raising the humerus.

BACK OF THE ARM.

Position of the part.

Position. During the examination of the back of the arm, the limb is to be raised in a semiflexed position by means of a block beneath the elbow. The scapula is to be brought nearly in a line with the humerus, so as to tighten the muscular fibres ; and it is to be fastened with hooks in that position.

Dissection (fig. 22). On the back of the arm there is one muscle, the triceps, beneath which are placed the musculo-spiral nerve and superior profunda vessels. The skin having been reflected and the bursa over the olecranon process having been looked for, the muscle will be laid bare readily, for it is covered only by fascia. To take away the fascia, carry an incision along the middle of the limb to the point of the elbow; and in reflecting it the loose subaponeurotic tissue should be removed at the same time.

Lay bare the triceps,

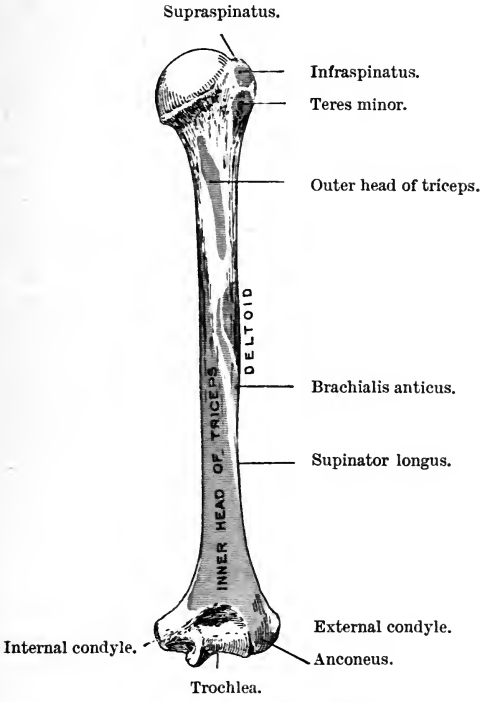


FIG. 21.—THE HUMERUS FROM BEHIND.

Separate the middle from the inner and outer heads of the muscle, and clear the interval between them, tracing the musculo-spiral nerve and vessels beneath the muscle. Define the outer head, which reaches down to the spot at which the musculo-spiral nerve appears on the outer side.

and separate pieces.

The TRICEPS MUSCLE (fig. 22) is divided superiorly into three heads of origin, inner, outer, and middle. Two of these are attached to the humerus, and one to the scapula.

Triceps muscle has three heads:

The *middle* or *long head* (A) has a tendinous *origin*, about an inch wide, from a rough mark on the axillary margin of the scapula close to the glenoid cavity, where it is united with the capsule of the shoulder-joint. The *outer head* (B) *arises* from the back of the

origin of middle head,

of outer head.

humerus along a narrow attachment extending from the root of the large tuberosity to the spiral groove. The *inner head* (c), fleshy and wide, *arises* from the posterior surface of the humerus below the spiral groove, reaching laterally to the intermuscular septa, and gradually tapering upwards as far as the insertion of the teres major. From the different heads the fibres are directed with varying degrees of inclination to a wide common tendon above the elbow. Inferiorly the muscle is *inserted* into the end of the olecranon process of the ulna, and gives an expansion to the aponeurosis of the forearm. Between the tip of the olecranon and the tendon there is sometimes a small bursa.

and of inner head ;

direction of the fibres ;

insertion ;

relations ;

FIG. 22.—DISSECTION OF THE DORSAL SCAPULAR VESSELS AND NERVE, AND OF THE TRICEPS MUSCLE.

Muscles :

A. Long head of triceps.
B. Outer head, with a bit of whalebone beneath it to mark the extent of its attachment down the humerus.
C. Inner head.
D. Anconeus.
E. Supinator longus.
F. Extensor carpi radialis longior.
G. Teres major.
H. Teres minor.
I. Infraspinatus, cut across.
J. Supraspinatus, cut through.

Arteries :

a. Suprascapular.
b. Dorsal scapular.
c. Posterior circumflex.

Nerves :

1. Suprascapular.
2. Circumflex.

The triceps is superficial, except at the upper part where it is overlapped by the deltoid muscle. It lies on the humerus, the musculo-spiral nerve, the superior profunda vessels, and the articulation of the elbow. On the sides the muscle is united to the intermuscular septa ; and the lowest fibres are continuous externally with the anconeus—a muscle of the forearm.

use.

Action. All the pieces of the triceps combining in their action will bring the ulna into a line with the humerus, and extend the elbow-joint. As the long head passes the shoulder it can depress the raised humerus, and adduct the arm.

Two intermuscular septa :

The INTERMUSCULAR SEPTA should be carefully noticed. They

are fibrous processes continuous with the investing aponeurosis of the arm, which are fixed to the ridges leading to the condyles of the humerus, separating the muscles of the front and back of the limb, and giving attachment to the fleshy fibres.

The *internal* is the stronger, and reaches as high as the coraco-brachialis muscle, from which it receives some tendinous fibres. The brachialis anticus is attached to it in front, and the triceps behind ; the ulnar nerve and the inferior profunda and anastomotic vessels pierce it. an inner and

The *external septum* is thinner, and ceases at the deltoid muscle. Behind it is the triceps ; and in front are the brachialis anticus and the muscles of the forearm (supinator longus and extensor carpi radialis longior) arising above the condyle of the humerus : it is pierced by the musculo-spiral nerve and the accompanying vessels. an outer.

Dissection. To follow the *superior profunda vessels* and the *musculo-spiral nerve*, the middle and outer heads of the triceps should be cut across over them, and the fatty tissue should be removed. The trunks of the artery and nerve are to be afterwards followed below the outer head of the triceps to the front of the humerus. The veins may be taken away. Dissection of vessels and nerve.

To trace out the branches of the nerve and artery which descend to the elbow and the anconeus muscle, the triceps is to be divided along the line of union of the outer with the middle head.

The SUPERIOR PROFUNDA branch of the brachial artery (see fig. 19, p. 46) turns to the back of the humerus with the musculo-spiral nerve between the inner and outer heads of the triceps ; in this position it supplies branches to the triceps and deltoid muscles, and is continued onwards in the groove in the bone to the outer part of the arm, where it divides in to its *terminal offsets* (*anterior* and *posterior*). One of these, which is very small, courses on the musculo-spiral nerve to the front of the elbow, anastomosing with the recurrent radial branch ; while a larger one descends along the intermuscular septum to the elbow, and joins the anastomotic and posterior inter-osseous recurrent arteries. Superior profunda artery lies behind the humerus,

Branches. Besides the terminal offsets of the vessel, a considerable branch descends to the elbow in the inner head of the triceps, supplying the muscle, and communicating with the inferior profunda and anastomotic branches of the brachial artery. One slender twig accompanies a branch of the musculo-spiral nerve, and ends in the anconeus muscle below the outer condyle of the humerus. supplies triceps, and joins anastomoses around elbow;

Two or more *cutaneous offsets* arise on the outer side of the arm, and accompany the superficial nerves. cutaneous offsets.

The MUSCULO-SPIRAL NERVE (fig. 4,[4] p. 15) is the largest trunk of the posterior cord of the brachial plexus (p. 25), and is continued along the back and outer part of the limb to the hand. In the arm the nerve winds with the superior profunda artery beneath the triceps muscle. At the outer aspect of the arm it is continued between the brachialis anticus and supinator longus muscles to the external condyle of the humerus, in front of which it divides into the radial and Musculo-spiral nerve winds to outer side of the arm.

posterior interosseous nerves (fig. 37,[2] and [3]). The brachialis anticus and supinator longus muscles are sometimes partly blended, and it may be necessary in such cases to cut through some muscular fibres to fully expose the last part of the nerve. The nerve gives muscular branches and cutaneous offsets to the inner and outer sides of the limb.

Branches.

Internal cutaneous branch.

a. The *internal cutaneous branch* of the arm (fig. 20,[6] also fig. 15, p. 39) is of small size, and arises in the axillary space in common with the branch to the inner head of the triceps; it is directed across the posterior boundary of the axilla to the inner side of the arm, where it becomes cutaneous in the upper third, and is distributed as before said (p. 43).

Two external cutaneous.

b. The *external cutaneous branches*, springing at the outer side of the limb, are two in number; they are distributed in the integuments of the arm and forearm (pp. 42 and 57).

Branches to the triceps, ulnar collateral and anconeus,

c. The *muscular branches* to the triceps are numerous, and supply all three heads. One slender offset (often called the *ulnar collateral* branch) for the inner head arises in common with the internal cutaneous branch, and descends close to the ulnar nerve to enter the muscular fibres at the lower third of the arm. Another long and slender branch behind the humerus, appearing as if it ended in the triceps, can be followed downwards to the anconeus muscle.

brachialis anticus and muscles of forearm.

d. On the outer side of the limb the musculo-spiral nerve supplies the brachialis anticus in part, and two muscles of the forearm, viz., supinator longus and extensor carpi radialis longior.

Directions.

Directions. As the dissection of the arm has been completed as far as the elbow, it will be advisable to keep moist the shoulder-joint until it is examined with the other ligaments.

Section IV.

THE FRONT OF THE FOREARM.

Position of the limb.

Position. The limb is to be placed with the palm of the hand uppermost; and the marking of the surface and the projections of bone are first to be noted.

Surface of the forearm.

Surface-marking. On the anterior aspect of the forearm are two lateral depressions, corresponding with the position of the main vessels. The external is placed over the radial artery, and inclines towards the middle of the limb as it approaches the elbow. The internal groove is evident only below the middle of the forearm, and points out the place of the ulnar artery.

Bony projections.

The bones (radius and ulna) are sufficiently near the surface to be traced in their whole length: each ends below in a point on either side of the wrist—the styloid process; and that of the radius is the lower. A transverse line separates the forearm from the hand, and the articulation of the wrist is about three-quarters of an inch above it.

Line of the wrist-joint.

Surface of palm of the hand.

On each side of the palm of the hand is a large projection; the external of these (thenar) is formed by muscles of the thumb, and the internal (hypothenar) by muscles of the little finger. At the upper end of the latter the prominent pisiform bone is easily felt; and towards the outer side of the wrist, below the end of the radius, the tuberosity of the scaphoid bone is to be recognised. Between the muscular eminences is the hollow of the palm, which is pointed towards the wrist. Two transverse lines are seen in the palm, but neither reaches completely across it; they result from the bending of the fingers at the metacarpo-phalangeal articulations, but the lower one is nearly half an inch above the three inner joints when the fingers are extended.

Position of palmar arches.

The position of the superficial palmar arch of arteries is marked by the middle third of a line drawn across the palm from the root of the thumb when that digit is placed at a right angle to the hand; the deep palmar arch is about a finger's breadth nearer the wrist.

Surface of the fingers.

Transverse lines on the palmar aspects of the thumb and fingers correspond to the articulations of the phalanges; but while the middle and lower ones are a little above the two interphalangeal articulations, the upper one is fully half an inch below the metacarpo-phalangeal joint.

Dissection to remove the skin.

Dissection. With the limb lying flat on the table, an incision is to be carried through the skin along the middle of the front of the forearm, as far as an inch beyond the wrist; and at its termination a transverse one is to cross it. The skin is to be reflected carefully from the front and back of the forearm, without injury to the numerous superficial vessels and nerves beneath; and it should be taken also from the back of the hand by prolonging the ends of the transverse cut along each margin to a little beyond the knuckles. The whole of the forefinger should have the integument removed from it, in order that the nerves may be followed to the end.

Seek the superficial vessels and nerves in front,

The superficial vessels and nerves can be now traced in the fat: they have the following position, and most of them have been partly dissected:—along the inner side, with the ulnar veins, is the continuation of the internal cutaneous nerve; and near the wrist there is occasionally a small offset from the ulnar nerve. On the outer side, with the radial vein, is the superficial part of the musculo-cutaneous nerve.

Close to the hand, in the centre of the forearm, and inside the tendon of the flexor carpi radialis, which can be rendered tense by extending the wrist, the small palmar branch of the median nerve should be sought beneath the fat. On the ulnar artery, close outside the pisiform bone, a small palmar branch of the ulnar nerve is to be looked for.

behind,

Near the middle of the back of the forearm the large external cutaneous branch of the musculo-spiral nerve is to be traced onwards; and offsets are to be followed to this surface of the limb from the nerves in front on either side.

and on the back of the hand.

On the posterior part of the hand is a plexus of superficial veins. Winding back below the ulna is the dorsal branch of the ulnar

nerve ; and lying along the outer border of the hand is the radial nerve : these should be traced to the fingers.

Subcutaneous veins :

CUTANEOUS VEINS. The superficial veins are named median, radial, and ulnar, from their position in the limb.

plexus on the hand ;

DORSAL PLEXUS OF THE HAND. This network receives the superficial veins from both surfaces of the fingers ; and from it, on the outer and inner sides, the radial and posterior ulnar veins proceed.

radial ;

The RADIAL VEIN begins in the outer part of the plexus above mentioned, and in some small radicles at the back of the thumb. It is continued along the forearm, at first behind and then on the outer border as far as the elbow, where it gives rise to the cephalic vein by its union with the outer branch of the median vein (fig. 16, p. 40). In many bodies a considerable branch passes from the lower part of the radial vein to join the median vein on the front of the forearm.

ulnar,

The ULNAR VEINS (fig. 16) are anterior and posterior, and occupy the front and back of the limb.

anterior

The *anterior* begins near the wrist by the junction of small roots from the hand, and runs on the inner part of the forearm to the elbow, where it opens either into the median-basilic or posterior ulnar vein.

and posterior ;

The *posterior ulnar vein* arises from the inner part of the dorsal plexus of the hand, and is continued along the back of the forearm nearly to the elbow ; here it bends forward to join the inner branch of the median and form the basilic vein.

median.

The MEDIAN VEIN takes origin near the wrist by small branches which are derived from the palmar surface of the hand. It is directed along the centre of the forearm nearly to the elbow, and there divides into median-basilic and median-cephalic, which unite, as before seen, with the radial and ulnar veins. At its point of bifurcation the median receives a large communicating branch from the deep veins beneath the fascia.

Superficial nerves of forearm

CUTANEOUS NERVES (fig. 15, p. 39, and fig. 23, p. 57). Some of the superficial nerves of the forearm are continued from the arm, those on the inner side from the large internal cutaneous nerve and those on the outer from the lower external cutaneous branch of the musculo-spiral and the musculo-cutaneous. On the fore part of the

and back of hand are—

limb there is occasionally a small offset of the ulnar nerve near the wrist. On the back of the hand is the termination of the radial nerve, together with the dorsal branch of the ulnar nerve.

internal cutaneous,

The INTERNAL CUTANEOUS NERVE (p. 49) is divided into two. The *anterior branch* extends on the front of the forearm as far as the wrist, and supplies the integuments on the inner half of the anterior surface. Near the wrist it communicates sometimes with a cutaneous offset from the ulnar nerve (fig. 15). The *posterior branch* continues along the back of the forearm (ulnar side) to the lower part (fig. 23).

external cutaneous ;

The MUSCULO-CUTANEOUS NERVE (cutaneous part, p. 50) is prolonged on the radial border of the limb to the ball of the thumb, over which it terminates in cutaneous offsets. Near the wrist the nerve is placed over the radial artery, and some twigs pierce the

fascia to ramify on the vessel, and supply the carpal articulations. A little above the middle of the forearm the nerve sends backwards a branch to the posterior aspect, which reaches nearly to the wrist, and communicates with the radial and the following cutaneous nerve (fig. 23).

The LOWER EXTERNAL CUTANEOUS BRANCH OF THE MUSCULO-SPIRAL NERVE (p. 42) descends along the hinder part of the fore- external cutaneous of musculo-spiral ;

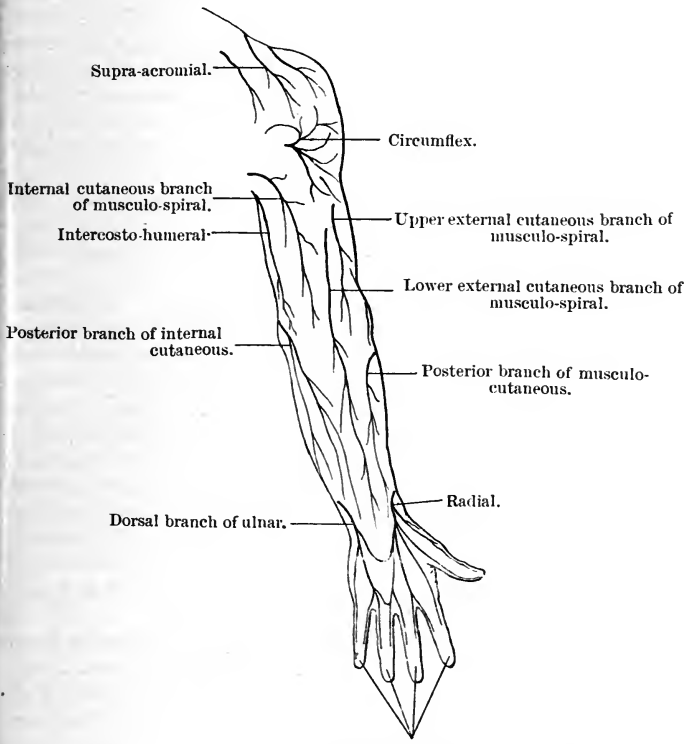


FIG. 23.—NERVES OF THE BACK OF THE ARM.

arm as far as the wrist. Near its termination it joins the preceding nerve (fig. 23).

The RADIAL NERVE ramifies in the integument of the back of radial nerve, the hand and some of the digits. It becomes cutaneous at the outer border of the forearm in the lower third, and, after giving some filaments to the posterior aspect of the limb, divides into two branches (fig. 23) :—

One (external) is joined by the musculo-cutaneous nerve, and is ending by external and distributed on the radial border and the ball of the thumb.

The other branch (internal) supplies the remaining side of the internal branches,

thumb, both sides of the next two digits, and half the ring finger; so that the radial nerve distributes the same number of digital branches to the dorsum as the median nerve furnishes to the palmar surface. This portion of the radial nerve communicates with the musculo-cutaneous and ulnar nerves; and the offset to the contiguous sides of the ring and middle fingers is joined by a twig from the dorsal branch of the ulnar nerve.

which supply digits;

The DORSAL BRANCH OF THE ULNAR NERVE (fig. 23) gives offsets to the rest of the fingers and the back of the hand. Appearing by the styloid process of the ulna, it joins the radial nerve in an arch across the back of the hand, and is distributed to both sides of the little finger, and to the ulnar side of the ring finger; it communicates with the part of the radial nerve furnished to the space between the ring and middle fingers; and sometimes it supplies this space entirely.

and branch of ulnar nerve to back of hand and fingers.

The dorsal digital nerves are much smaller than those on the palmar aspect, and cannot be followed on the fingers farther than the base of the second phalanx. On the sides of the finger each communicates with an offset from the palmar nerve.

Extent of nerves on fingers.

The APONEUROSIS of the forearm is continuous with the similar investment of the arm. It is of a pearly white colour, and is formed of fibres which cross obliquely. The membrane is thicker behind than in front, and is stronger near the elbow than towards the wrist. At the upper part it receives prolongations from the tendon of the biceps in front, and of the triceps behind; and it gives origin to the muscles springing from the condyles of the humerus. Longitudinal white lines indicate the position of deep processes (intermuscular septa), which separate the muscles, and give origin to their fleshy fibres. On the back of the forearm the fascia is attached to the hinder border of the ulna, and to the margins of a triangular surface at the upper end of that bone, which is left subcutaneous.

Deep fascia of forearm:

at the wrist;

At the wrist the fascia joins the anterior annular ligament; and near that band the tendon of the palmaris longus pierces it, and receives a sheath from it. Close to the pisiform bone there is an aperture through which the ulnar vessels and nerve enter the fat of the hand. Behind the wrist it is thickened by transverse fibres, giving rise to the posterior annular ligament; but on the back of the hand and fingers the fascia becomes very thin.

posterior annular ligament.

Take away fascia, nerves, and veins.

Dissection. The skin is now to be replaced on the back of the forearm and hand, in order that the denuded parts may not become dry. Beginning the dissection on the anterior surface of the limb, let the student divide the aponeurosis as far as the wrist, and take it away with the cutaneous vessels and nerves, except the small palmar cutaneous offsets of the median and ulnar nerves near the hand. In cleaning the muscles it will be impossible to remove the aponeurosis from them at the upper part of the forearm without cutting the muscular fibres.

Clean out hollow of elbow.

In front of the elbow is the hollow, already partly dissected, between the two masses of muscles arising from the inner and outer

sides of the humerus. The space should be carefully cleaned, so as to display the brachial and forearm vessels, the median nerve and branches, the musculo-spiral nerve, and the recurrent radial and ulnar arteries.

In the lower half of the forearm a large artery, radial, is to be laid bare along the outer side of the tendon of the flexor carpi radialis; and at the inner side, close to the annular ligament, the trunk of the ulnar artery will be recognised as it becomes superficial. These vessels and their branches should be carefully cleaned; and the adjoining muscles may be fixed with stitches to prevent their displacement.

The anterior annular ligament of the wrist, which arches over the tendons passing to the hand, is next to be defined. This strong band is at some depth from the surface; and while the student removes the fibrous tissue superficial to it, he must take care of the small branches of the median and ulnar nerves to the palm of the hand. The ulnar vessels and nerve (covered by an expansion connected with the tendon of the flexor carpi ulnaris internal to the pisiform bone) pass over the ligament, and will serve as a guide to its depth.

Define anterior annular ligament.

FIG. 24.—SUPERFICIAL VIEW OF THE FOREARM (QUAIN'S "ARTERIES").

1. Radial artery, with its nerve outside.
2. Ulnar artery and nerve.
3. Pronator teres.
4. Flexor carpi radialis.
5. Palmaris longus.
6. Flexor sublimis digitorum.
7. Flexor carpi ulnaris.
8. Supinator longus.
9. Biceps.

Hollow in front of the elbow:

HOLLOW IN FRONT OF THE ELBOW (fig. 25). This hollow is situate between the inner

boundaries; and the outer muscles of the forearm, and is triangular in shape, with the wider part towards the humerus. It is bounded on the outer side by the supinator longus muscle, and on the inner side by the pronator teres. The aponeurosis of the limb is stretched over the space; and the bones, covered by the brachialis anticus and supinator brevis, form the deep boundary.

contents of the space *Contents.* In the hollow are lodged the termination of the brachial artery, with its veins, and the median nerve; the musculo-spiral nerve; the tendon of the biceps muscle; and small recurrent vessels, with much fat.

and their position to one another; These several parts have the following relative position:—The tendon of the biceps is directed towards the outer boundary to reach the radius; and on the outer side, concealed by the supinator longus muscle, is the musculo-spiral nerve. Nearly in the centre of the space are the brachial vessels and the median nerve, the nerve being internal; but as the artery is inclined to the outer side of the limb, they soon become distant from one another about half an inch. The brachial artery divides here into two trunks, radial and ulnar; and the recurrent radial and ulnar branches appear in the space, the former on the outer, and the latter on the inner side.

lymphatic glands. Two or three lymphatic glands lie on the sides of the artery, and one below its point of splitting.

Muscles on the Front of the Forearm (fig. 24). The muscles on the front of the forearm are divided into a superficial and a deep group.

Superficial group contains five muscles. In the superficial group there are five muscles, which are fixed to the inner condyle of the humerus by a common tendon, and lie in the undermentioned order from the outer to the inner side:—(1) pronator radii teres, (2) flexor carpi radialis, (3) palmaris longus, (4) flexor carpi ulnaris; and deeper and larger than any of these is (5) the flexor sublimis digitorum.

The deep group will be met with in a subsequent dissection (p. 67).

Pronator teres: The pronator radii teres (fig. 24,[3]) *arises* from the inner condyle of the humerus by the common tendon, from the ridge above the

origin by two heads; condyle by fleshy fibres (fig 17, p. 44), from the fascia over it, from the septum between it and the flexor carpi radialis, and by a second tendinous slip from the inner edge of the coronoid process of the

insertion; ulna. It is *inserted* by a flat tendon into an impression, an inch in length, on the middle of the outer surface of the radius (fig. 36, p. 86).

relations; The muscle is superficial except at the insertion, where it is covered by the radial artery, and some of the outer set of muscles, viz., supinator longus and radial extensors of the wrist. The pronator forms the inner boundary of the triangular space in front of the elbow; and its inner border touches the flexor carpi radialis. By gently separating the muscle from the rest, it will be found to lie on the brachialis anticus, the flexor sublimis digitorum, and the ulnar artery and the median nerve, the small deep head of origin intervening between the artery and nerve.

Action. The pronator assists in bringing forwards the radius over the ulna, so as to pronate the hand. When the radius is fixed, the muscle raises that bone towards the humerus, bending the elbow-joint. use on radius and elbow.

The FLEXOR CARPI RADIALIS (fig. 24, [4]) takes its *origin* from the common tendon, from the aponeurosis of the limb, and from the intermuscular septum on each side of it. The tendon of the muscle, becoming free from fleshy fibres about the middle of the forearm, passes through a groove in the trapezium, in a special sheath at the outer side of the anterior annular ligament, to be *inserted* mainly Radial flexor of the wrist.

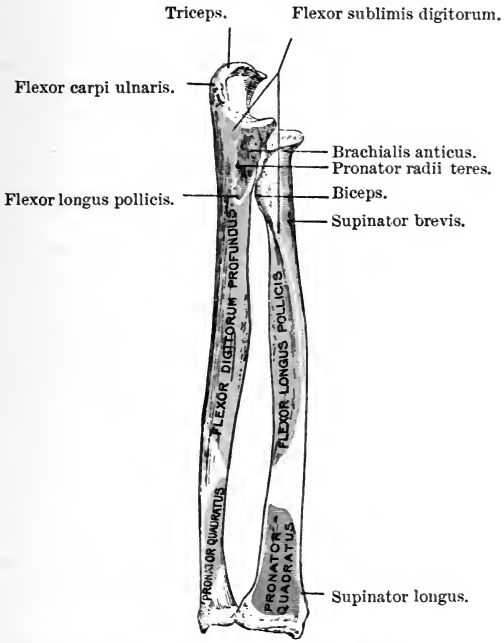


FIG. 25.—THE RADIUS AND ULNA FROM THE FRONT.

into the base of the metacarpal bone of the index finger, and by a slip into that of the middle finger.

The muscle rests chiefly on the flexor sublimis digitorum; but near the wrist it lies over the flexor longus pollicis,—a muscle of the deep group. As low as the middle of the forearm the flexor carpi radialis corresponds externally with the pronator teres, and below that with the radial artery, to which its tendon is taken as the guide. The ulnar border is in contact at first with the palmaris longus muscle, and for about two inches above the wrist with the median nerve. The muscle is superficial, is the guide to radial artery.

Action. The hand being free, the muscle first flexes the wrist-joint, inclining the hand somewhat to the radial side; and it will Use on wrist and radius.

assist in bringing forwards the lower end of the radius in pronation. Still continuing to contract, it bends the elbow.

Long palmar muscle

The PALMARIS LONGUS (fig. 24,5) is sometimes absent, or it may present great irregularity in the proportion between the fleshy and tendinous parts. It *arises*, like the preceding muscle, from the common tendon, the fascia, and the intermuscular septa. Its slender tendon is continued along the centre of the forearm; and piercing the aponeurosis, it passes over the annular ligament to end in the palmar fascia, sending a slip to the abductor muscle of the thumb.

lies over annular ligament and joins fascia of palm;

The palmaris is situate between the flexor carpi radialis and ulnaris, and rests on the flexor sublimis digitorum.

use.

Action. Rendering tense the palmar fascia, the palmaris will afterwards bend the wrist and elbow, like the last muscle.

Flexor carpi ulnaris: origin by two heads;

The FLEXOR CARPI ULNARIS (fig. 24,7) *arises* by a narrow slip in common with the other muscles from the inner condyle of the humerus, from the intermuscular septum between it and the flexor sublimis digitorum, and by a broad aponeurosis from the inner margin of the olecranon and the posterior border of the ulna for the upper two-thirds of its length (fig. 36, p. 86). The fibres pass downwards and forwards to a tendon on the anterior aspect of the muscle in the lower half, some joining it as low as the wrist. The tendon is

insertion;

inserted into the pisiform bone, from which fibrous bands pass on to the hook of the unciform and to the base of the fifth metacarpal bones representing the distal part of the tendon (the *pisi-unciform* and *pisi-metacarpal* ligaments). Also a process passes inwards from the tendon near its insertion on to the face of the anterior annular ligament covering over the ulnar artery and nerve.

adjacent parts;

One surface of the muscle is in contact with the fascia; and its tendon, which can be felt readily through the skin, serves as the guide to the ulnar artery. To its radial side are the palmaris and flexor sublimis digitorum muscles. When the attachment to the inner condyle has been divided, the muscle will be seen to conceal the flexor profundus digitorum, the ulnar nerve, and the ulnar vessels; between the attachments to the condyle and the olecranon the ulnar nerve enters the forearm.

use.

Action. The wrist is bent, and the hand is drawn inwards by the contraction of the muscle.

Course and extent of the radial artery.

The RADIAL ARTERY (fig. 24,1) is one of the vessels derived from the bifurcation of the brachial trunk, and extends to the palm of the hand. It is placed first along the outer side of the forearm as far as the end of the radius; next it winds backwards below the extremity of that bone; and finally it enters the palm of the hand through the first interosseous space. In consequence of this circuitous course, the artery will be found in three different dissections, viz., the front of the forearm, the back of the wrist, and the palm of the hand.

Situation in the forearm.

In the front of the forearm. In this region of the limb the position of the artery will be marked on the surface by a line from the centre of the hollow of the elbow to the fore part of the styloid

process of the radius. This vessel is smaller than the ulnar artery, though it appears in direction to be the continuation of the brachial trunk. It is partly deep and partly superficial; and where it is superficial, it can be felt beating as the pulse near the wrist during life.

In its *upper half* the vessel is placed under cover of the supinator longus (8); and it rests successively on the following muscles:—the tendon of the biceps (9), the fleshy supinator brevis, the pronator teres (3), and part of the thin, radial origin of the flexor sublimis (6). Relations to muscles: in upper half;

In its *lower half* the artery is superficial, being covered only by the integuments and the deep fascia. Here it is placed in a hollow between the tendons of the supinator longus (8) and flexor carpi radialis (4), and it lies, in this part, from above down on the origin of the flexor sublimis, on two muscles of the deep group, viz., flexor longus pollicis and pronator quadratus, and lastly on the end of the radius. in lower half;

Veins. Venæ comites lie on the sides, with cross branches over the artery. to veins;

Nerve. The radial nerve is on the outer side of the artery in the upper two-thirds of the forearm, but is separated from the vessels by a slight interval near the elbow. In the lower third the nerve passes backwards and becomes superficial behind the tendon of the supinator longus. to nerve.

Branches. The radial artery in this part of its course furnishes many unnamed muscular and cutaneous offsets, and three named branches, viz., recurrent radial, superficial volar, and anterior carpal. Branches:

a. The *radial recurrent* (fig. 24) is the first branch, and supplies the muscles on the outer side of the limb. Its course is almost transverse to the supinator longus, beneath which it terminates in that muscle and the two radial extensors of the wrist. One offset ascends beneath the supinator, and anastomoses with the superior profunda branch of the brachial artery. radial recurrent;

b. The *superficial volar branch* (fig. 27, *c*, p. 72) is very variable in size, and arises near the lower end of the radius. It is directed towards the palm of the hand, across or through the mass of muscles in the ball of the thumb; and it either ends in those muscles, or joins the superficial palmar arch. superficial volar;

c. The *anterior carpal branch* is very small, and will be seen in the examination of the deep muscles. Arising rather above the end of the radius, it passes transversely inwards at the lower border of the pronator quadratus, and anastomoses with a similar branch from the ulnar artery. From the arch thus formed offsets are given to the carpus. anterior carpal.

Peculiarities of the radial artery. Sometimes the radial arises high in the arm, and its course then is close to the brachial artery, along the edge of the biceps muscle; and in passing the bend of the elbow it is occasionally subcutaneous, *i.e.*, above the deep fascia, and liable to injury in venesection. In the forearm the artery may likewise be subcutaneous, and superficial to the supinator longus muscle. Variations of the radial artery.

Dissection. To bring into view the flexor sublimis digitorum, the flexor carpi radialis and palmaris longus must be cut through Dissection of flexor sublimis.

near the inner condyle of the humerus, and turned to one side. Small branches of the ulnar artery and median nerve may be seen entering the under-surfaces of those muscles. For the present the pronator teres may be left uncut.

Superficial flexor of fingers: origin from three bones of limb;

The FLEXOR SUBLIMIS DIGITORUM (flexor perforatus, fig. 24,[6]) is the largest of the superficial muscles, and is named from its position to another flexor in the deep set. It *arises* in common with the foregoing muscles from the inner condyle of the humerus and the intermuscular septa, also from the internal lateral ligament of the elbow-joint and the inner margin of the coronoid process of the ulna, and by a thin layer from the oblique line of the radius, as well as frequently from the anterior border of that bone for a distance of one or two inches below the insertion of the pronator teres (fig. 25). Below the middle of the forearm the muscle ends in four tendons, which are continued beneath the annular ligament and through the

insertion;

hand, to be *inserted* into the middle phalanges of the fingers (fig. 32, p. 78), after being perforated by the tendons of the deep flexor.

relations;

The flexor sublimis is in great part concealed by the other muscles of the superficial group; and the radial vessels lie on the attachment to the radius. Along the inner border is the flexor carpi ulnaris, with the ulnar vessels and nerve. The tendons of the muscle are arranged in pairs before they pass beneath the annular ligament of the wrist, the middle and ring finger tendons being anterior, and those of the index and little finger posterior in position. On dividing the condylar and coronoid attachments the muscle will be seen to cover two deep flexors (flexor profundus digitorum and flexor longus pollicis), the median nerve, and the upper part of the ulnar artery.

use on fingers,

Action. The flexor bends first the middle and then the proximal joints of the fingers; but when the first phalanges are fixed by the extensor of the fingers, the superficial flexor moves the second phalanges alone.

on elbow and wrist.

After the fingers are bent the muscle will help in flexing the wrist and elbow-joints.

Ulnar artery ends in palm of hand.

The ULNAR ARTERY (fig. 26, G) is the larger of the two branches coming from the bifurcation of the brachial trunk, and is directed along the inner side of the limb to the palm of the hand, where it forms the superficial palmar arch, and supplies most of the fingers. In the forearm the vessel has an arched direction; and its depth from the surface varies in the first and last parts of its course.

Course in upper half

In the *upper half* the artery is inclined obliquely inwards from the centre of the elbow to the inner side of the limb. It courses

and relations to muscles;

between the superficial and deep muscles, being covered by the pronator teres, flexor carpi radialis, palmaris longus, and flexor sublimis. Beneath it lies on the brachialis anticus for a short distance, and afterwards on the flexor profundus (C).

in lower half;

In the *lower half* it has a straight course to the pisiform bone, and is covered by the integuments and fascia, and by the flexor

relations to muscles:

carpi ulnaris. To the outer side are the tendons of the flexor sublimis. Beneath it is the flexor profundus (C).

Veins. Two veins accompany the artery, and are united across it at intervals.

Nerves. The median nerve (1) lies to the inner side of the vessel for about an inch, but then crosses over it to gain the outer side, the coronoid head of the pronator teres being placed between the two. Rather above the middle of the forearm the ulnar nerve (4) reaches the artery, and continues thence on the inner side; and a small branch (5), sending twigs around the artery, courses on it to the palm of the hand.

On the *annular ligament* the artery has passed through the fascia, and lies close to the pisiform bone. The ulnar nerve, with its palmar branch, still accompanies the vessel on the inner side.

Branches. The greater number of the offsets of the artery are distributed to the muscles. Its named branches are the following:—

a. The *anterior ulnar recurrent branch* fre-

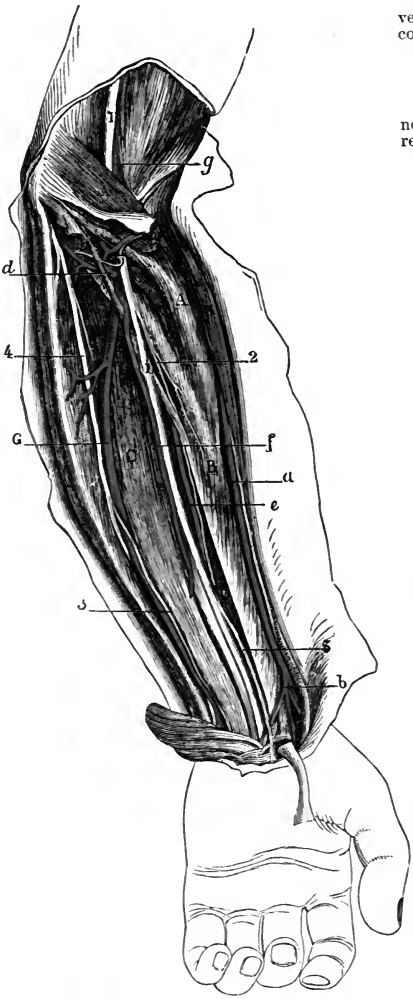


FIG. 26.—DISSECTION OF THE DEEP MUSCLES OF THE FOREARM, AND OF THE VESSELS AND NERVES BETWEEN THE TWO GROUPS OF MUSCLES (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Pronator teres.
B. Flexor longus pollicis.
C. Flexor profundus digitorum.
D. Pronator quadratus.
E. Flexor carpi ulnaris.

Arteries:

a. Radial trunk.
b. Superficial volar branch.
G. Ulnar trunk.
d. Its posterior recurrent branch.
e. Anterior interosseous.
f. Median artery.
g. Brachial trunk.

Nerves:

1. Median.
2. Anterior interosseous.
3. Cutaneous palmar branch.
4. Ulnar trunk.
5. Cutaneous palmar branch of ulnar.

quently arises in common with the next, and ascends on the brachialis anticus muscle, to join the branch of the anastomotic artery beneath the pronator teres. It gives offsets to the contiguous muscles.

posterior recurrent,

b. The *posterior ulnar recurrent branch* (*d*), of larger size than the anterior, is directed beneath the flexor sublimis muscle to the interval between the inner condyle and the olecranon. There it passes with the ulnar nerve between the attachments of the flexor carpi ulnaris, and joins the ramifications of the inferior profunda and anastomotic arteries on the inner side of the elbow-joint. Some of its offsets enter the muscles, and others supply the articulation and the ulnar nerve.

interosseous,

c. The *interosseous artery* is a short thick trunk, which is directed backwards towards the interosseous membrane, and divides into anterior and posterior branches, which will be afterwards followed.

carpal,

d. The *carpal branches* (anterior and posterior) ramify on the front and back of the carpus, on which they anastomose with corresponding offsets of the radial artery, and form arches across the wrist.

and metacarpal.

e. The *metacarpal branch* arises from the artery near the lower end of the ulna, and runs along the metacarpal bone of the little finger, of which it is the inner dorsal branch.

The origin and course may vary.

Peculiarities of the ulnar artery. The *origin* of the artery may be transferred to any point of the main vessel in the arm or axilla. In one instance R. Quain found the ulnar artery arising between two and three inches below the elbow.

When it begins higher than usual, it is generally superficial to the flexor muscles at the bend of the elbow, but beneath the aponeurosis of the forearm, though sometimes it is subcutaneous with the superficial veins.

Ulnar nerve in the forearm.

The ULNAR NERVE (fig. 26, [4]) enters the forearm between the attachments of the flexor carpi ulnaris to the olecranon and inner condyle of the humerus. Under cover of that muscle the nerve reaches the ulnar artery somewhat above the middle (in length) of the forearm, and is continued on the inner side of the vessel to the hand. On the annular ligament the nerve is rather deeper than the artery. It gives off the following branches :—

Its branches are

to elbow-joint ;

a. Articular nerves. In the interval between the olecranon and the inner condyle, slender filaments are furnished to the joint.

to two muscles of forearm ;

b. Muscular branches arise from the nerve near the elbow, and supply the flexor carpi ulnaris and the inner half of the flexor profundus digitorum.

cutaneous branch of palm of hand ;

c. Cutaneous nerve of the forearm and hand (fig. 15, p. 39). A small palmar branch ([5]) arises about the middle of the forearm, and descends on the ulnar artery, sending twigs around that vessel, to end in the integuments of the palm of the hand ; sometimes a cutaneous offset perforates the aponeurosis near the wrist, and joins the internal cutaneous nerve.

d. The *dorsal cutaneous nerve of the hand* (fig. 23, p. 57) leaves the trunk about two inches above the end of the ulna, and passes obliquely backwards beneath the flexor carpi ulnaris; perforating the aponeurosis, it is distributed on the back of the hand and fingers (p. 58). cutaneous nerve of back of hand.

The MEDIAN NERVE (fig. 26, 1) leaves the hollow of the elbow between the heads of the pronator teres, and runs in the middle line of the limb to the hand. It is placed beneath the flexor sublimis as low as two inches from the annular ligament, where it becomes superficial along the outer border of the tendons of that muscle. Lastly, the nerve passes beneath the annular ligament to the palm of the hand, and its position in this part may be marked on the surface by the tendon of the palmaris longus. It supplies the muscles on the front of the forearm, and furnishes a cutaneous offset to the hand. Median nerve lies between the two groups of muscles.

Muscular offsets leave the trunk of the nerve near the elbow, and are distributed to all the superficial muscles except the flexor carpi ulnaris; in addition the nerve supplies the deep layer of muscles through its interosseous branch (p. 69), except the inner half of the flexor profundus digitorum. It supplies the front muscles, except one and a half,

The *cutaneous palmar branch* (3) arises in the lower fourth of the forearm; it pierces the fascia near the annular ligament, and crosses over that band to reach the palm (fig. 15, p. 39). and a branch to palm of hand.

The RADIAL NERVE is the smaller of the two branches into which the musculo-spiral divides at the elbow. This nerve is placed along the outer border of the limb, under cover of the supinator longus and on the outer side of the radial artery, to the junction of the middle and lower thirds of the forearm, where it becomes cutaneous at the posterior border of the supinator tendon. It finally divides into two branches, which are distributed on the dorsum of the hand and digits (fig. 23). No muscular offset is furnished by the nerve. Radial nerve to forearm. It ends on back of the hand.

Dissection (fig. 26). To examine the deep layer of muscles it will be necessary to draw well over to the radial side of the forearm the pronator teres, to detach the flexor sublimis from the radius, and to remove its fleshy part. A thin layer of fascia, which is most distinct near the wrist, is to be taken away; and the anterior interosseous vessels and nerve, which lie on the interosseous membrane, and are concealed by the muscles, are to be traced out. Dissection of deep muscles.

Over the bones at the lower end of the forearm the arch of the anterior carpal arteries may be defined. Show carpal arch.

DEEP GROUP OF MUSCLES. There are three deep muscles on the front of the forearm. One, covering the ulnar, is the deep flexor of the fingers; a second rests on the radius, the long flexor of the thumb; and the third is the pronator quadratus, which lies beneath the other two, over the lower ends of the bones. Three muscles in the deep set.

The FLEXOR PROFUNDUS DIGITORUM (flexor perforans, fig. 26, c) *arises* from the anterior and inner surfaces of the ulnar for three-fourths of the length of the bone (fig. 25, p. 60), from the inner half of the interosseous ligament for the same distance, and from the aponeurosis of the flexor carpi ulnaris. The muscle has a thick Deep flexor of fingers: origin;

fleshy belly, and ends in tendons which, passing beneath the annular ligament, are *inserted* into the last phalanges of the fingers (fig. 32, p. 78). The portion of the muscle furnishing the tendon to the index finger is separated from the rest by a layer of areolar tissue, and arises chiefly from the interosseous membrane.

insertion;

parts around it;

Lying over the muscle are the ulnar vessels and nerve, the superficial flexor of the fingers, and the flexor carpi ulnaris. The deep surface rests on the ulna and the pronator quadratus muscle. The outer border touches the flexor longus pollicis and the anterior interosseous vessels and nerve.

use on fingers and wrist.

Action. The muscle bends the joints of the fingers and the wrist; but it does not act on the last phalanx till after the second has been moved by the flexor sublimis.

How fingers are bent.

The fingers are usually bent in the following order:—firstly, the articulation between the first (proximal) and the middle phalanges; secondly, the last phalangeal joint; and thirdly, the metacarpo-phalangeal.

Long flexor of thumb: origin;

The FLEXOR LONGUS POLLICIS (fig. 26, B) *arises* from the anterior surface of the radius below the oblique line (fig. 25), as low as the pronator quadratus, and from the outer part of the interosseous membrane; it is also joined in most cases by a distinct slip arising in common with the flexor sublimis digitorum either from the internal condyle of the humerus or the coronoid process of the ulna. The fleshy fibres descend to a tendon, which is continued beneath the annular ligament, and is *inserted* into the last phalanx of the thumb.

insertion;

parts above and beneath it;

The greater part of the muscle is covered by the flexor sublimis digitorum; and the radial vessels rest on it for a short distance below. It lies on the radius and the pronator quadratus. To the inner side is the flexor profundus digitorum.

use.

Action. This muscle is the special flexor of the last joint of the thumb, but it also aids in bending the other joints of that digit and the wrist.

Pronator quadratus

The PRONATOR QUADRATUS (fig. 26, D) is a flat muscle covering the lower fourth of the bones of the forearm. It *arises* from the anterior surface of the ulna, where it is widened by a somewhat linear and partly tendinous origin, and is *inserted* into the fore and inner parts of the radius for about two inches (fig. 25).

is deep in position;

The anterior surface is covered by the tendons of the flexor muscles of the digits, and by the radial vessels; and the posterior surface rests on the radius and ulna with the intervening membrane, and on the interosseous vessels and nerve. Along its lower border is the arch formed by the anterior carpal arteries.

use.

Action. The end of the radius is moved inwards over the ulna by this muscle, and the hand is pronated.

Anterior interosseous artery.

The ANTERIOR INTEROSSEOUS ARTERY (fig. 26, *e*) is continued on the front of the interosseous membrane between the two flexors or in the fibres of the flexor profundus digitorum, till it reaches an aperture in the membrane near the upper border of the pronator quadratus. At that spot the artery turns from the front to the back of the limb, and descends to the back of the carpus, where

it ends by anastomosing with the posterior interosseous and carpal arteries.

Branches. Numerous offsets are given to the deep muscles. Branches: muscular,

One long branch, *median* (*f*), accompanies the median nerve, which it supplies, and either ends in the flexor sublimis, or is continued beneath the annular ligament to the palmar arch. median,

Above the middle of the forearm the *medullary arteries* of the radius and ulna arise from the vessel. medullary to the bones,

Where it is about to pass through the interosseous membrane it furnishes twigs to the pronator quadratus; and one branch is continued beneath that muscle to anastomose with the anterior carpal arteries. and carpal.

The ANTERIOR INTEROSSEOUS NERVE (fig. 27, [2]) is derived from the median, and accompanies the artery of the same name to the pronator quadratus muscle, the under-surface of which it enters. Branches are given by it to the flexor longus pollicis and to the outer part of the flexor profundus digitorum muscles. Anterior interosseous nerve ends in pronator.

Dissection. The attachment of the biceps and brachialis anticus to the bones of the forearm may be now cleaned and examined. Dissection.

The *insertion of the brachialis anticus* takes place by a broad thick tendon, about an inch in length, which is fixed into the inner and lower parts of the rough impression on the front of the coronoid process of the ulna. Insertion of brachialis anticus.

Insertion of the biceps. The tendon of the biceps is inserted into the rough hinder part of the tuberosity of the radius, a bursa separating it from the fore part of the prominence. Near its attachment the tendon is twisted, so that the anterior surface becomes external. The supinator brevis muscle partly surrounds the insertion. Insertion of biceps.

SECTION V.

THE PALM OF THE HAND.

Dissection (fig. 27, p. 72). The digits should be well separated and fixed firmly to a board with tacks, and the skin reflected from the palm of the hand by means of *two incisions*. One is to be carried along the centre of the palm from the wrist to the fingers; and the other is to be made from side to side at the termination of the first. In raising the inner flap, the small palmaris brevis muscle will be seen at the inner margin of the hand; and its insertion into the skin may be left till the muscle has been learnt. In the fat the ramifications of the palmar branches of the median and ulnar nerves are to be traced. Dissection. Clean small palmar muscle, and trace cutaneous nerves.

The student should remove the fat from the palmaris muscle, and from the strong palmar fascia in the centre of the hand; and he should take care not to destroy a fibrous band (transverse ligament) which lies across the roots of the fingers. When cleaning the fat Define the palmar fascia,

digital vessels and nerves;

from the palmar fascia he will recognise, opposite the clefts between the fingers, the digital vessels and nerves, and must be especially careful of two, viz., those of the inner side of the little finger and outer side of the index finger, which appear higher up in the hand than the rest, and are more likely to be injured. By the side of the vessels and nerves to the fingers four slender lumbricales muscles are to be exposed.

and expose digital sheaths.

Lastly, the skin and the fat may be reflected from the thumb and fingers by an incision along each, in order that the sheaths of the tendons with the collateral vessels and nerves may be laid bare.

Cutaneous palmar nerves,

Cutaneous palmar nerves. Small twigs are furnished to the integument from both the median and ulnar nerves in the hand; and two branches descend from the forearm.

one from median,

One is the offset of the median nerve (p. 67) which crosses the annular ligament; it extends to about the middle of the palm, and is united with the palmar branch of the ulnar; a few filaments are furnished to the ball of the thumb.

the other from ulnar.

The other palmar branch is derived from the ulnar nerve (p. 66), and has been traced on the ulnar artery to the hand; it is distributed to the upper and inner part of the palm.

Palmaris brevis is a cutaneous muscle;

The PALMARIS BREVIS (fig. 28, H) is a small flat muscle, about an inch and a half wide, the fibres of which are collected into separate bundles. It *arises* from the palmar aponeurosis, and its fibres are directed transversely to their *insertion* into the skin at the inner border of the hand.

This muscle lies over the ulnar vessels and nerve. After it has been examined it may be thrown inwards with the skin.

use.

Action. It draws outwards and wrinkles the skin of the inner side of the palm.

Palmar fascia.

The PALMAR FASCIA or aponeurosis consists of a central and two lateral parts; but the lateral, which cover the muscles of the thumb and little finger, are so thin as not to require a special notice.

Its central part

The *central part* is a strong, white layer, which is pointed at the wrist, but expanded towards the fingers, where it nearly covers the palm of the hand. Above, the fascia receives the tendon of the palmaris longus, and is connected to the annular ligament; and

ends in a piece for each finger,

below, it ends in four processes, which are continued downwards, one for each finger, to the sheaths of the tendons. At the point of separation of the pieces from one another some transverse fibres are placed, which arch over the lumbricalis muscle and the digital vessels and nerve appearing at this spot. From the pieces of the

and in the skin.

fascia a few superficial longitudinal fibres are prolonged to the integument near the cleft of the fingers.

Dissection.

Dissection. Now follow one of the digital processes of the fascia to its termination. First remove the superficial fibres, and then divide the process longitudinally by inserting the knife beneath it opposite the head of the metacarpal bone.

Deep ending of the pieces of fascia.

Ending of the processes. Each process of the fascia sends backwards an offset on each side of the tendons, which is fixed to the

deep ligament connecting together the heads of the metacarpal bones, and to the edge of the metacarpal bone for a short distance.

Transverse ligament of the fingers.

The *superficial transverse ligament of the fingers* is a thin fibrous band, which stretches across the roots of the four fingers, and is contained in the fold of skin, forming the rudiment of a web between them. Beneath it the digital nerves and vessels are continued onwards to their terminations.

Sheath of the tendons varies in thickness; has a synovial sac.

Sheath of the flexor tendons. Along each finger the flexor tendons are retained in place against the phalanges by a fibrous sheath. Opposite the middle of the first and second phalanges the sheath is strengthened by a strong fibrous band (*vaginal ligament*), which is almost tendinous in consistence, but opposite the joints it consists of a thin membrane with scattered and oblique fibres. The sheath will be opened later on in the examination of the flexor tendons.

Dissection.

Dissection. The palmar fascia should next be taken away. On the removal of the fascia the palmar arch of the ulnar artery and the median and ulnar nerves become apparent.

Superficial palmar arch: position in the hand; relations.

PALMAR PART OF THE ULNAR ARTERY (fig. 28). In the palm of the hand the ulnar artery divides into two branches, *superficial* and *deep*. The larger—*superficial*—branch is directed towards the muscles of the thumb, where it communicates with two offsets of the radial trunk, viz., the superficial volar branch (*c*) and the branch to the radial side of the forefinger (*f*). The curved part of the artery, which lies across the hand, is named the *superficial palmar arch* (*d*). Its convexity is turned towards the fingers, and its position in the palm would be nearly marked by a line across the hand from the cleft of the thumb.

The arch is comparatively superficial, being covered for the most part only by the integuments and the palmar fascia; but at the inner border of the hand the palmaris brevis muscle (H) lies over it. Beneath it are the flexor tendons and the branches of the ulnar and median nerves. Venæ comites lie on its sides.

Deep branch; p. 77

The *deep* or *communicating branch of the ulnar artery* (fig. 31[2], p. 77) passes backwards with the deep part of the ulnar nerve, between the abductor and short flexor muscles of the little finger, to inosculate with the deep palmar arch of the radial artery (p. 80).

Branches. From the convexity of the superficial arch proceed the digital arteries, and from the concavity some small offsets to the palm of the hand.

four digital branches:

The *digital branches* (*g*) are four in number, and supply both sides of the three inner fingers and one side of the index finger. The branch to the inner side of the hand and little finger is undivided; but the others, lying over the three inner interosseous spaces, bifurcate below to supply the contiguous sides of the corresponding digits. In the palm these branches are accompanied by the digital nerves, which they sometimes pierce.

these join offsets of the deep arch:

Near the roots of the fingers they receive communicating branches from offsets of the deep arch; but the digital artery of the inner

side of the little finger has its communicating branch about the middle of the palm.

termination on the fingers;

From the point of bifurcation the arteries extend along the sides of the fingers; and over the last phalanx the vessels of opposite

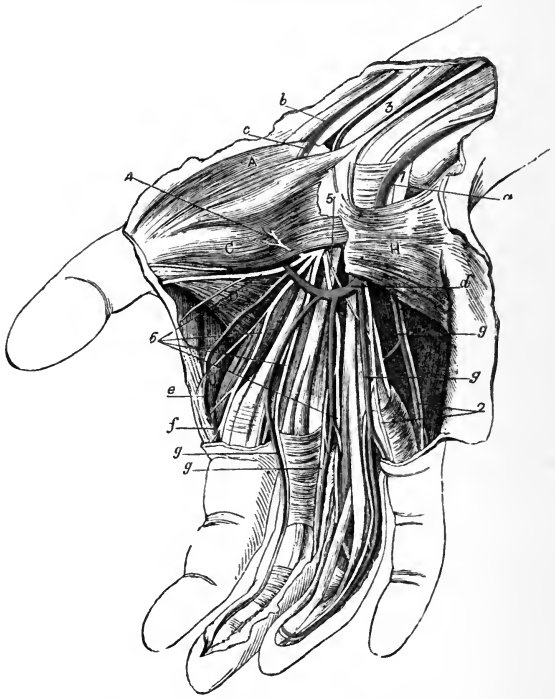


FIG. 27.—SUPERFICIAL DISSECTION OF THE PALM OF THE HAND (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Abductor pollicis.
C. Outer head of flexor brevis.
D. Abductor transversus pollicis.
H. Palmaris brevis.

Arteries:

a. Ulnar.
b. Radial.
c. Superficial volar branch.
d. Superficial palmar arch.
e. Branch uniting the arch with *f*, the radial digital branch of the forefinger.
g. Digital branches of the superficial arch.

Nerves:

1. Ulnar, and 2, its two digital branches.
3. Median, and 5, its digital branches.
4. Branch of the median to thumb-muscles.
5 (on the annular ligament). Communicating branch from the median to the ulnar.

sides unite in an arch, from the convexity of which offsets proceed to supply the ball of the finger. Branches are furnished to the

and arches

finger and the sheath of the tendons; and twigs are supplied to the

phalangeal articulations from small arterial arches on the bones, an arch being close above each joint. On the dorsum of the last phalanx is a plexus from which the nail pulp is supplied.

Ulnar nerve in the hand

PALMAR PART OF THE ULNAR NERVE (fig. 27, 1). The ulnar nerve, like the artery, divides, on or near the annular ligament, into a *superficial* and a *deep* part.

divides into deep and superficial parts.

The *deep part* accompanies the deep branch of the artery to the muscles, and will be dissected with that vessel (fig. 31).

The *superficial part* furnishes an offset to the palmaris brevis muscle, and some filaments to the integument of the inner part of the hand, and ends in two digital nerves for the supply of both sides of the little finger and half the next.

Digital nerves are two.

Digital nerves (2). The more internal nerve is undivided, like the corresponding artery.

The other is directed to the cleft between the ring and little fingers, and bifurcates for the supply of their opposed sides; in the palm of the hand this branch is connected with an offset (3) of the median nerve.

Along the sides of the fingers the digital branches have the same arrangement as those of the median nerve.

Median nerve supplies muscles and digits.

PALMAR PART OF THE MEDIAN NERVE (fig. 27, 3). As soon as the median nerve issues from beneath the annular ligament it becomes enlarged and somewhat flattened, and divides into two nearly equal parts for the supply of digital nerves to the thumb and the remaining two fingers and a half; the outer part also furnishes a small muscular branch to the ball of the thumb. The branches of the nerve are covered by the fascia and the superficial palmar arch; and beneath them are the tendons of the flexor muscles.

Branch to muscles.

a. The *muscular branch* (4) supplies the flexor brevis, the abductor, and the opponens pollicis muscles.

Five digital nerves:

b. The *digital nerves* (5) are five in number. Three of them are undivided, and come from the external of the two pieces into which the trunk of the median splits. The other two spring from the inner piece of the nerve, and are bifurcated, each supplying the opposed sides of two fingers.

first two,

The *first two* nerves belong to the thumb, one on each side, and the outer one communicates with a branch of the radial nerve.

third,

The *third* is directed to the radial side of the index finger, and gives a branch to the most external lumbrical muscle.

fourth,

The *fourth* furnishes a nerve to the second lumbrical muscle, and divides to supply the contiguous sides of the fore and middle fingers.

fifth.

The *fifth* also divides into two branches, which are distributed to the opposed sides of the middle and ring fingers; it communicates with a branch of the ulnar nerve.

On the sides of the fingers:

On the fingers. On the sides of the fingers the nerves are in front of the arteries, and reach to the last phalanx, where they end in filaments for the ball, and the pulp beneath the nail. In their course downwards the nerves supply chiefly tegumentary branches. One of these (the *dorsal branch*) is directed backwards by the side of

lateral offsets.

the first phalanx, and, after uniting with the digital nerve on the back of the finger, is continued to the dorsum of the last phalanx.

Dissection of the flexor tendons.

Dissection. The tendons of the flexor muscles may next be followed to their termination. To expose them, the ulnar artery should be cut through below the origin of the deep branch ; and the superficial volar branch of the radial having been divided, the palmar arch is to be thrown towards the fingers. The ulnar and median nerves are also to be cut below the annular ligament, and turned downwards.

Divide annular ligament

A longitudinal incision is to be made through the centre of the annular ligament without injuring the muscles that arise from it, and the pieces of the ligament are to be thrown to the sides.

and open sheaths.

Finally, the sheaths of the fingers may be opened in order to show the insertion of the tendons.

Synovial sac surrounds tendons.

Flexor Tendons. Beneath the annular ligament the tendons of the deep and superficial flexors are surrounded by a large and loose synovial membrane, which projects upwards into the forearm and downwards into the hand, and sends an offset into the digital sheath of the thumb, and usually one into that of the little finger (fig. 28). The synovial sheath belonging to the tendon of the flexor longus pollicis is often separate from the rest.

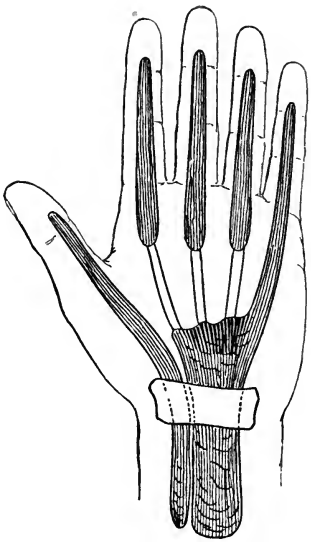


Fig. 28.—Synovial Sheaths of the Flexor Tendons.

Superficial flexor tendons

Flexor sublimis. The tendons of the flexor sublimis are superficial to those of the deep flexor beneath the ligament ; and all four are nearly on the same level, instead of being arranged in pairs as in the forearm. After crossing the palm of the hand they enter the digital sheaths (figs. 29 and 30) ; and each is *inserted* by two processes into the margins of the middle phalanx, about the centre. As it enters the sheath, the tendon of the flexor sublimis conceals that of the flexor profundus ; but opposite the lower half of the first phalanx it is split for the passage of the latter tendon.

in the hand : insertion ;

slit for the deep flexor.

Dissection.

Dissection. To see the tendons of the deep flexor and the lumbrical muscles, the flexor sublimis must be cut through above the wrist, and thrown towards the fingers. Afterwards the synovial membrane and areolar tissue should be taken away.

Tendons of deep flexor

Flexor profundus. At the lower border of the annular ligament the tendinous mass of the flexor profundus is divided into four pieces, though in the forearm only the tendon of the index finger is

distinct from the rest. From the ligament the four tendons are directed through the hand to the fingers; and in their course they give origin to the small lumbricales muscles. At the root of the finger each enters the digital sheath with a tendon of the flexor sublimis, and having passed through that tendon, is *inserted* into the base of the last phalanx (fig. 30). cross the hand. to their insertion.

Between both flexor tendons and the bones are short folds of the synovial membrane, one for each (vincula accessoria, *ligamenta* Short folds to both

Fig. 29.

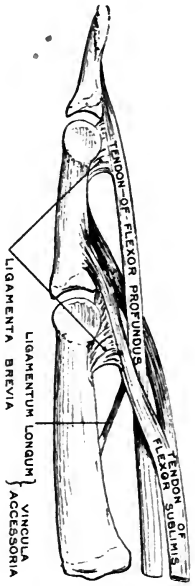


Fig. 30.

FIGURES OF THE TENDONS AND SHORT MUSCLES OF ONE FINGER, WITH THE SHEATH OF THE FLEXOR TENDONS.

a. Extensor tendon, with interosseous (*b*) and lumbrical (*c*) muscles joining it.

d. Tendon of flexor sublimis passing into its sheath, the thicker parts of which are marked *e* and *f*.

brevia, fig. 30). By means of this each tendon is connected with the capsule of the joint, and the lower part of the phalanx immediately above the bone into which it is inserted. A thin fold (*ligamentum longum*) will also be seen passing to the shaft of the first phalanx. flexor tendons.

The LUMBRICALES (fig. 31, I, p. 77) are four small muscular slips, which *arise* from the tendons of the deep flexor near the annular Lumbrical muscles:

origin, ligament ; the outer two springing each from a single tendon, while the inner two are connected each with two tendons. They are
insertion, directed to the radial side of the fingers, to be *inserted* into the expanded extensor tendon on the dorsal aspect of the metacarpal phalanx (fig. 30, *c*).

relations, These muscles are concealed for the most part by the tendons and vessels that have been removed ; but, as already seen, they are subcutaneous for a short distance between the processes of the palmar fascia.

and use. *Action.* The lumbricales assist in bending the metacarpo-phalangeal joints, and, by their insertion into the extensor tendons, they straighten the interphalangeal joints.

Tendon of long flexor of thumb ; *Tendon of the flexor longus pollicis.* Beneath the annular ligament this tendon is external to the flexor profundus ; and in the hand it inclines outwards between the outer head of the flexor brevis and
its insertion. the adductor obliquus pollicis (fig. 31), to be *inserted* into the last phalanx of the thumb. The common synovial membrane surrounds it beneath the annular ligament, and sends a prolongation, as before said, into its digital sheath.

Dissection of deep arch, **Dissection** (fig. 31). The deep palmar arch with the deep branch of the ulnar nerve, and some of the interosseous muscles, will come into view if the flexor profundus is cut above the wrist, and thrown with the lumbricales muscles towards the fingers ; but in raising the tendons the student should preserve the fine nerves and vessels entering the inner two lumbrical muscles.

and of muscles of thumb and little finger. The short muscles of the thumb and little finger are next to be prepared. Some care is necessary in making a satisfactory separation of the different small thumb-muscles ; but those of the little finger are more easily defined.

Five muscles to thumb. SHORT MUSCLES OF THE THUMB (fig. 31). These are five in number. The most superficial is the abductor pollicis (A) ; and beneath it is the opponens pollicis (B), which will be recognised by its attachment to the whole length of the metacarpal bone. To the inner side of the last is the short flexor (C) ; below this and below the tendon of the long flexor is the adductor obliquus (C′) ; and the wide muscle coming from the third metacarpal bone is the adductor transversus (D).

Abductor: The ABDUCTOR POLLICIS (A) is the most superficial muscle, and is about an inch wide. It *arises* from the upper part of the annular
attachments, ligament on the outer side, and from the tuberosity of the scaphoid bone ; and it is *inserted* into the base of the first phalanx of the thumb at the radial margin, sending a slip to join the tendon of the extensor longus pollicis.

relations, The muscle is subcutaneous, and rests on the opponens pollicis ; it is joined at its origin by a slip from the tendon of the palmaris longus, and often by one from the extensor ossis metacarpi pollicis.

and use. *Action.* The abductor pollicis moves the thumb in the direction of its radial border away from the index finger.

Dissection. **Dissection.** The opponens pollicis will be seen on cutting through the abductor. To separate the muscle from the short

flexor on the inner side, the student should begin near the head of the metacarpal bone, where there is usually a slight interval.

The OPPONENS POLLICIS (B) *arises* from the annular ligament beneath the preceding, from the tubercle of the scaphoid beneath

Opponens fixed to metacarpal bone

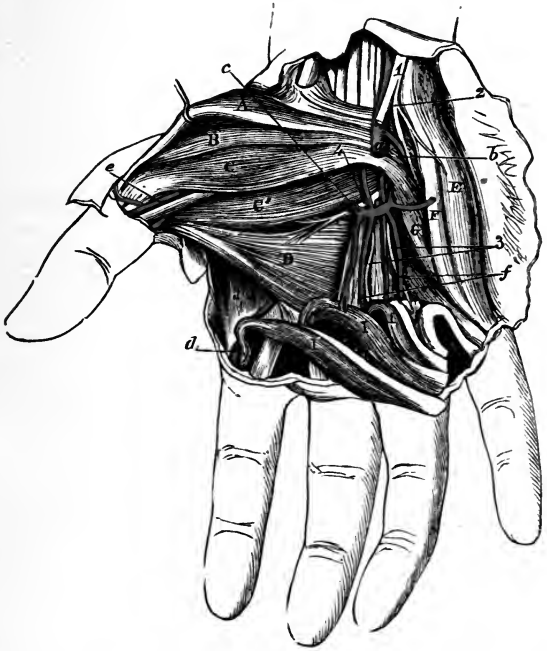


FIG. 31.—DEEP DISSECTION OF THE PALM OF THE HAND (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Abductor pollicis.
B. Opponens pollicis.
C. Flexor brevis pollicis.
C'. Adductor obliquus pollicis.
D. Adductor transversus pollicis.
E. Abductor minimi digiti.
F. Flexor brevis minimi digiti.
G. Opponens minimi digiti.
I. Lumbricales.
J. First dorsal interosseous.

Vessels:

a. Ulnar artery, cut.
b. Its deep branch.
c. Deep palmar arch.
d. Radial digital artery of the index finger.
e. Arteria princeps pollicis.
f. Interosseous arteries.

Nerves:

1. Ulnar nerve, cut.
2. Its deep part, continued at 4 to some of the thumb muscles.
3. Offsets to the inner two lumbricales.

the abductor, and from the outer side of the ridge of the trapezium; and it is *inserted* into the outer surface and radial border of the metacarpal bone for the whole length.

This muscle is for the most part concealed by the abductor, beneath former;

though it projects on its outer side. Along its inner border is the flexor brevis pollicis.

use. *Action.* It draws the metacarpal bone inwards over the palm, rotating it at the same time, so as to turn the ball of the thumb towards the fingers, thus producing the movement of opposition.

Flexor brevis pollicis. The FLEXOR BREVIS POLLICIS * (c) *arises* from the lower border of the outer part of the annular ligament, and is *inserted* into the outer margin of the base of the first phalanx of the thumb; its

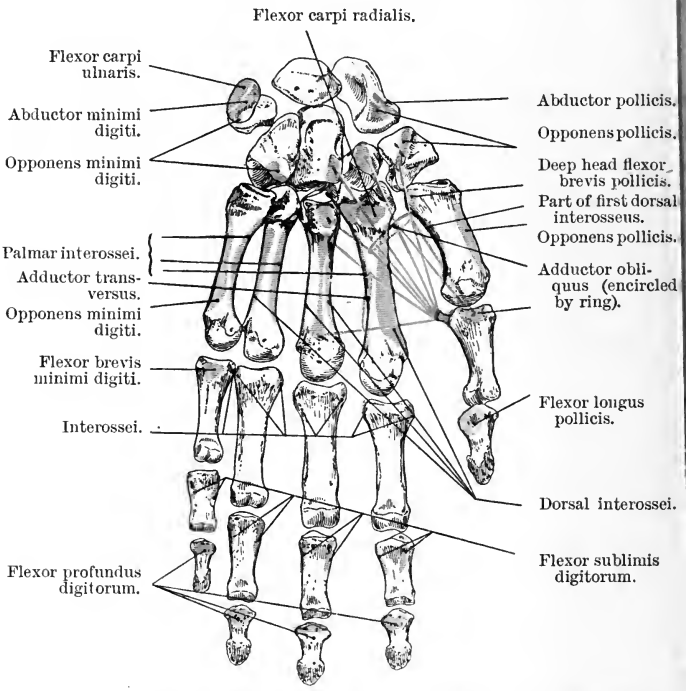


FIG. 32.—THE BONES OF THE HAND SHOWING THE MUSCULAR ATTACHMENTS.

outer head to external sesamoid bone; relations; use. tendon contains a sesamoid bone close to its insertion. It lies along the inner border of the opponens pollicis, and is superficial to the tendon of the long flexor.

Action. The muscle bends the metacarpo-phalangeal joint, and assists the opponens in drawing the thumb forwards and inwards over the palm.

* An *inner head* of the flexor brevis is commonly described as a small slip, which is concealed by the adductor obliquus pollicis, and which will be subsequently seen to pass from the ulnar side of the first metacarpal bone to be *inserted* into the first phalanx with that muscle. It belongs, however, to the same plane of muscles as the adductors, and will be described with the adductor obliquus pollicis.

The ADDUCTOR OBLIQUUS POLLICIS (c′) *arises* deeply in the hand from the sheath of the flexor carpi radialis, the anterior ligaments of the carpus, the os magnum, and the bases of the first, second, and third metacarpal bones (fig. 32). Directed obliquely downwards and outwards, the greater part of the muscle is *inserted* into the ulnar side of the base of the first phalanx in union with the adductor transversus, a sesamoid bone being formed in the tendon over the head of the metacarpal bone. A small slip of the muscle usually passes outwards beneath the tendon of the long flexor to join the insertion of the outer head of the flexor brevis. Adductor obliquus: origin; passes to internal sesamoid bone, and sends a slip to external;

The tendon of the flexor longus pollicis lies between this muscle and the flexor brevis; and its origin is covered by the outer tendons of the flexor profundus and the lumbricales. It lies over the first dorsal interosseous muscle, and the ending of the radial artery. relations;

Action. It flexes the metacarpo-phalangeal joint, and draws the thumb over the palm. use.

The ADDUCTOR TRANSVERSUS POLLICIS (d) is triangular in shape, with the apex at the thumb, and the base in the centre of the palm. Its *origin* is from the ridge on the lower two-thirds of the palmar aspect of the third metacarpal bone (fig. 32); and its *insertion* is into the inner side of the first phalanx of the thumb, in common with the last muscle. From the conjoined insertion of the two adductors a slip is sent to the tendon of the extensor longus pollicis. Adductor transversus joins adductor obliquus;

The anterior surface is in contact with the tendons of the flexor profundus and the lumbrical muscles; and the posterior surface lies over the interosseous muscles of the first and second spaces, with the intervening metacarpal bone. The deep palmar arch separates this muscle from the adductor obliquus. relations

Action. It draws the thumb towards the centre of the palm. and use.

SHORT MUSCLES OF THE LITTLE FINGER (fig. 31). In the hypothenar eminence there are the abductor and opponens muscles of the little finger, and sometimes a short flexor. Two or three muscles to little finger.

The ABDUCTOR MINIMI DIGITI (e) is superficial to the opponens muscle. It *arises* from the pisiform bone, and is *inserted* into the ulnar side of the base of the first phalanx of the little finger; an offset from it reaches the extensor tendon on the back of the phalanx. The palmaris brevis partly conceals the muscle. Abductor is beneath skin;

Action. Firstly it draws the little finger away from the others; but continuing to act, it bends the metacarpo-phalangeal joint. use.

The FLEXOR BREVIS MINIMI DIGITI (f) is placed at the radial border of the preceding muscle. It takes *origin* from the tip of the process of the unciform bone, and slightly from the annular ligament; and it is *inserted* with the abductor into the first phalanx. Flexor brevis is often absent;

It lies on the opponens; and near its origin it is separated from the abductor by the deep branches of the ulnar artery and nerve. relations

Action. It flexes and abducts the first phalanx of the little finger. and use.

Opponens: attachments, The OPPONENS MINIMI DIGITI (G) resembles the opponens pollicis in being attached to the metacarpal bone. Its *origin* is from the hook of the unciform bone, and the lower part of the annular ligament; its *insertion* is into the ulnar side of the metacarpal bone of the little finger.

relations, The opponens is partly overlaid by the preceding muscles; and beneath it the deep branches of the ulnar artery and nerve pass.

and use. *Action.* It raises the inner metacarpal bone, and moves it towards the others, so as to deepen the hollow of the palm.

Dissection of deep arch and **Dissection.** The radial artery comes into the hand between the first two metacarpal bones; and to lay bare the vessel it will be requisite to detach the origin of the adductor obliquus pollicis. The deep palmar arch and the branch of the ulnar nerve accompanying it, together with their offsets, are to be dissected out.

interosseous muscles and fascia. A fascia which covers the interosseous muscles is to be removed, after the dissector has observed its connection with the transverse ligament uniting the heads of the metacarpal bones.

Radial artery in hand RADIAL ARTERY IN THE HAND (fig. 31). The radial artery enters the palm at the first interosseous space, between the heads of the first dorsal interosseous muscle; and after furnishing one branch to

forms deep arch, the thumb, and another to the index finger, it turns across the hand towards the ulnar side, forming the deep arch.

The *deep palmar arch* (*c*) extends from the upper end of the first interosseous space to the base of the metacarpal bone of the little

which lies near carpal bones, finger, where it joins the deep branch of the ulnar artery (*b*). Its convexity, which is but slight, is directed downwards; and its situation is nearer the carpal bones than that of the superficial arch. The arch has a deep position in the hand, and lies on the metacarpal

and beneath muscles, bones and the interosseous muscles. It is covered by the long flexor tendons, and in part by the adductor obliquus pollicis and opponens

with venæ comites. minimi digiti muscles. Two veins accompany it. The *branches* of the arch are the following:—

Branches: recurrent; *a. Recurrent branches* pass from the concavity of the arch to the front of the carpus; these supply the bones and joints, and anastomose with the anterior carpal arteries.

perforating; *b. Three perforating arteries* pierce the inner three dorsal interosseous muscles, and communicate with the interosseous arteries on the back of the hand.

palmar interosseous. *c.* Usually there are *three palmar interosseous arteries* (*f*), which lie over the inner three intermetacarpal spaces, and terminate by joining the digital branches of the superficial palmar arch at the clefts of the fingers. An offset of the inner one, or a separate branch of the arch, joins the digital artery to the inner side of the little finger (p. 71). These branches supply the interosseous muscles, and the two or three inner lumbricales; they vary much in their size and arrangement. Their size, as a rule, varies inversely with that of the corresponding digital branches of the superficial arch, which they join at the cleft between the fingers.

Digital branches: *d. Digital branches of the radial.* The *arteria princeps pollicis* (*e*) runs along the first metacarpal bone to the interval between the

adductor obliquus and the flexor brevis pollicis, where it divides into the two collateral branches of the thumb; these are distributed like the arteries of the superficial arch (p. 72). artery of the thumb;

e. The *radial digital branch of the index finger* (*d*) (arteria radialis indicis) is directed over the first dorsal interosseous muscle (J), and beneath the adductors of the thumb, to the radial side of the forefinger. At the lower border of the adductor transversus (D), this branch is usually connected by an offset with the superficial palmar arch; and at the end of the digit it unites with the branch furnished to the opposite side by the ulnar artery. artery of the fore-finger.

The DEEP PART OF THE ULNAR NERVE (2) accompanies the deep arterial arch as far as the muscles of the thumb, where it terminates in offsets to the two adductors. Deep branch of ulnar nerve;

Branches. Near its origin the nerve furnishes branches to the muscles of the little finger. In the palm it gives offsets to all the palmar and dorsal interosseous muscles, and to the inner two lumbrical muscles (3), besides the terminal branches before mentioned. muscular offsets.

The TRANSVERSE METACARPAL LIGAMENT is formed by cross fibres uniting the palmar ligaments of the metacarpo-phalangeal articulations of the fingers, and serves to bind together the heads of the inner four metacarpal bones. To its upper border the fascia covering the interosseous muscles is attached. The ligament should now be taken away to see the interosseous muscles. Transverse ligament of metacarpus.

The INTEROSSEOUS MUSCLES, so named from their position between the metacarpal bones, are seven in number. Two muscles occupy each space, except the first, where there is only one. They arise from the metacarpal bones, and are inserted into the first phalanges of the fingers and the expanded extensor tendons. They are divided into palmar and dorsal; but all are seen in the palm of the hand, though the former project more than the others. Seven interosseous muscles, divided into palmar and dorsal.

The *palmar muscles* (fig. 33), three in number, are smaller than the dorsal, and have each a single *origin* from the side of the metacarpal bone of the finger to which it belongs. The first is placed on the ulnar side of the index finger, the second and third on the radial side of the ring and little fingers respectively. Palmar go to index, ring, and little fingers.

The *dorsal muscles* (fig. 34), one in each space, *arise* by two heads from the lateral surfaces of the metacarpal bones between which they lie. The first (abductor indicis) is inserted on the radial side of the index finger, the second on the radial and the third on the ulnar side of the middle finger, and the fourth on the ulnar side of the ring finger. Dorsal: two to middle finger, one each to index and ring fingers.

Both sets of muscles have a similar termination (fig. 29, p. 75): the fibres end in a tendon, which is *inserted* into the side of the first or metacarpal phalanx, and sends an expansion to join the extensor tendon on the dorsum of the bone. Common insertion of both sets.

Action. They bend the metacarpo-phalangeal joints by their attachment to the first phalanx, and extend the two interphalangeal joints through their union with the extensor tendon. Action as flexors and extensors,

as abductors and adductors.

The interosseous muscles also separate and approximate the straightened fingers, the palmar set adducting the index, ring and little fingers towards the middle digit; while the dorsal abduct their fingers from the median line of the hand, the two fixed to the middle finger moving it to either side of that line.

Dissection.

Dissection. The attachments of the annular ligament to the carpal bones on each side are next to be dissected out by taking away the small muscles of the thumb and little finger. Before reading its description, the ends of the cut ligament may be placed in apposition, and fixed with a stitch.

Annular ligament of front of wrist.

The ANTERIOR ANNULAR LIGAMENT is a broad band, which arches over and binds down the flexor tendons of the fingers. It is

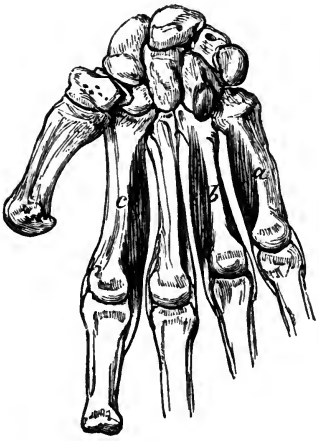


FIG. 33.—THE THREE PALMAR INTEROSSEOUS MUSCLES.

a. Muscle of the little finger.
b. Muscle of the ring finger.
c. Muscle of the index finger.

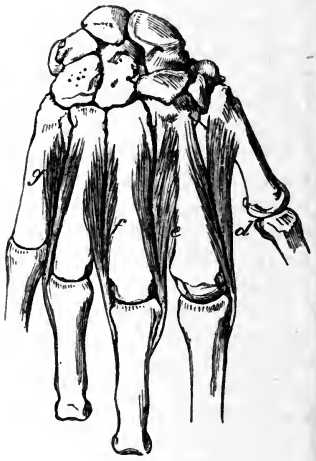


FIG. 34.—THE FOUR DORSAL INTEROSSEOUS MUSCLES.

d. Muscle of the index finger.
e and *f*. Muscles of the middle finger.
g. Muscle of the ring finger.

attached internally to the pisiform and the hook of the unciform, and externally to the tuberosity of the scaphoid and the ridge of the trapezium, as well as by a deeper process to the trapezoid bone on the inner side of the groove for the flexor carpi radialis. By its upper border it is continuous with the aponeurosis of the forearm; and anteriorly it is joined by the palmar fascia. Over it lie the palmaris longus tendon and the ulnar vessels and nerve.

Dissection.

Dissection. Follow the tendon of the flexor carpi radialis to its insertion into the metacarpal bones, by dividing the overlying part of the anterior ligament.

Insertion of flexor carpi radialis.

The *tendon of the flexor carpi radialis*, in passing through the hand to its insertion lies in a groove in the trapezium between the

attachments of the annular ligament, but not within the arch of that band; here it is bound down by a fibrous sheath and is lined by a synovial membrane. The tendon is *inserted* into the base of the metacarpal bone of the index finger, and sends a slip to that of the middle digit.

Section VI.

THE BACK OF THE FOREARM.

Position. During the dissection of the back of the forearm the limb lies on the front, and a small block is to be placed beneath the wrist for the purpose of stretching the tendons. Position.

Dissection (fig. 35). The fascia and the cutaneous nerves and vessels are to be reflected from the muscles of the forearm, and from the tendons on the back of the hand; but in removing the fascia in the forearm, the student must be careful not to cut away the posterior interosseous vessels, which are in contact with it on the ulnar side in the lower third. A thickened band of the fascia opposite the carpus (the posterior annular ligament) is to be left. Take away the superficial nerves and the fascia.

Let the integument be removed from the fingers, in order that the tendons may be traced to the end of the digits. Strip fingers.

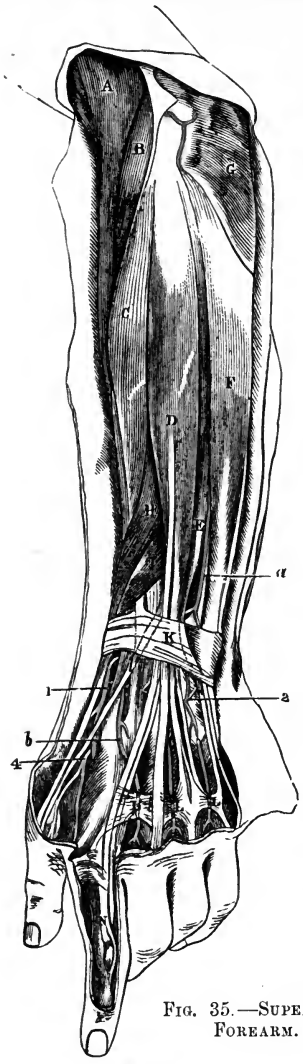
The several muscles should be separated from one another up to their origin, especially the two radial extensors of the wrist. Separate muscles.

The POSTERIOR ANNULAR LIGAMENT (K) is a part of the deep fascia, thickened by the addition of transverse fibres, and is situate opposite the lower ends of the bones of the forearm. This band is attached on the outer side to the radius, and on the inner side to the pyramidal and pisiform bones. Processes from it are fixed to the bones beneath, and confine the extensor tendons. The ligament will subsequently be examined more in detail. Annular ligament behind the wrist.

SUPERFICIAL LAYER OF MUSCLES (fig. 35). The muscles of the back of the forearm are arranged in a superficial and a deep layer. The superficial layer contains seven muscles, which arise, in part by a common tendon, from the outer side of the humerus, and are placed in the following order from without inwards:—the long supinator (A), the long and short radial extensors of the wrist (B and C), the common extensor of the fingers (D), the extensor of the little finger (E), and the ulnar extensor of the wrist (F). There is one other small muscle near the elbow—the anconeus (G). Superficial layer has seven muscles.

The SUPINATOR RADII LONGUS (A) reaches upwards into the arm, and limits on the outer side the hollow in front of the elbow. It *arises* from the upper two-thirds of the external supracondylar ridge of the humerus, and from the front of the external intermuscular septum of the arm. The fleshy fibres end about the middle of the forearm in a tendon, which is *inserted* into the lower end of the radius, close above the styloid process. Supinator longus: origin; insertion;

In the arm the margins of the supinator are directed towards the surface and the bone, but in the forearm the muscle is flattened over relations;



and use,

radius free

and fixed.

Extensor carpi radialis longior: origin;

the others, with its edges forwards and backwards. Its anterior border touches the biceps and the pronator teres; and the posterior is in contact with both radial extensors of the wrist. Near its insertion the supinator is covered by two extensors of the thumb. Beneath the muscle are the brachialis anticus and the musculospiral nerve, the extensors of the wrist, the radial vessels and nerve, and the radius.

Action. The chief use of the supinator longus is to bend the elbow-joint; but if the radius is either forcibly pronated or supinated, the muscle can put the hand into a state intermediate between pronation and supination.

If the radius is fixed, as in climbing, the muscle will bring up the humerus, bending the elbow.

The EXTENSOR CARPI RADIALIS LONGIOR (B) *arises* from the lower third of the external supracondylar ridge of the humerus, from the front of the external intermuscular septum, and from the septum between it and the next muscle. It lies on the short radial extensor, being partly covered by the supinator longus; and its tendon passes beneath the extensors of the thumb, and the annular

FIG. 35.—SUPERFICIAL DISSECTION OF THE BACK OF THE FOREARM. (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Supinator longus.
B. Extensor carpi radialis longior.
C. Extensor carpi radialis brevior.
D. Extensor communis digitorum.
E. Extensor minimi digiti.
F. Extensor carpi ulnaris.
G. Anconeus.
H. Extensor ossis metacarpi pollicis.
I. Extensor brevis pollicis.
J. Extensor longus pollicis.
K. Posterior annular ligament.
L. Bands uniting the tendons of the common extensor on the back of the hand.
N. Insertion of the common extensor into the second and third phalanges.

Arteries:

a. Posterior interosseous.
1. Radial.
2. Posterior carpal arch.
b. Dorsal interosseous branch.
4. Dorsal branches to thumb and forefinger.

ligament, to be *inserted* into the base of the metacarpal bone of the index finger. Along its outer border lies the radial nerve. insertion;

Action. The long extensor straightens the wrist and abducts the hand; it can also bend the elbow-joint. and use.

If the hand is fixed in climbing, it will act on the humerus like the long supinator.

The EXTENSOR CARPI RADIALIS BREVIOR (C) is attached to the outer condyle of the humerus by a tendon common to it and the three following muscles, viz., common extensor of the fingers, extensor of the little finger, and ulnar extensor of the wrist; it takes origin also deeply from the external lateral ligament of the elbow-joint. The tendon of the muscle is closely applied to the preceding, and after passing with it through the same compartment of the annular ligament, is *inserted* into the base of the metacarpal bone of the middle finger. Extensor carpi radialis brevior: origin; insertion;

Concealed on the outer side by the two preceding muscles, this extensor rests on the radius and two of the muscles attached to it, viz., supinator brevis, and pronator teres. Along its inner side is the common extensor of the fingers; and the extensors of the thumb issue between the two. Each radial extensor has usually a bursa beneath the tendon, close to its insertion. parts around it;

Action. This muscle acts in the same way as its fellow. and use.

The EXTENSOR COMMUNIS DIGITORUM (D) is single at its origin, but is divided below into four tendons. It *arises* from the common tendon, from the fascia, and from aponeurotic septa between it and the adjacent muscles. At the lower part of the forearm the muscle ends in four tendons, which pass through a compartment of the annular ligament with the extensor indicis, and are directed along the back of the hand to their insertion into the second and third phalanges of the fingers. Common extensor of fingers: origin; division into four tendons;

On the fingers the tendons have the following arrangement. On the dorsum of the first phalanx each forms an expansion with the tendons of the lumbricalis and interosseous muscles (fig. 29, p. 75). At the lower part of that phalanx the expansion divides into three parts (fig. 35, N);—the central one is fixed into the base of the second phalanx, while the lateral pieces unite, and are inserted into the base of the last phalanx. Opposite the first two articulations of each finger the tendon sends down lateral bands to join the capsule of the joint. On the fore and little fingers the expansion is joined by the special extensor tendons of those digits. insertion into the phalanges;

This muscle is placed between the extensors of the wrist and little finger, and conceals the deep layer. On the back of the hand the tendons are joined by cross bands (L), thinnest between the index finger tendon and its neighbour, and strongest between the ring finger tendon and its collateral tendons, so that they prevent the ring finger being raised if the others are closed. relations of the muscle;

Action. The muscle straightens the fingers and separates them from each other. It acts especially on the first phalanges, the two interphalangeal joints being extended mainly by the interosseous and lumbricales muscles. use, on the fingers,

on elbow and wrist. The digits being straightened, it will assist the other muscles in extending the wrist and the elbow.

Extensor of little finger: origin; termination; The EXTENSOR MINIMI DIGITI (E) is the most slender muscle on the back of the forearm, and appears to be but a part of the common extensor. Its *origin* is in common with that of the extensor communis, but it passes through a distinct sheath of the annular ligament. Beyond the ligament the tendon splits into two, and the outer part is joined by the fourth tendon of the common extensor: finally, both parts enter the common expansion on the first phalanx of the little finger.

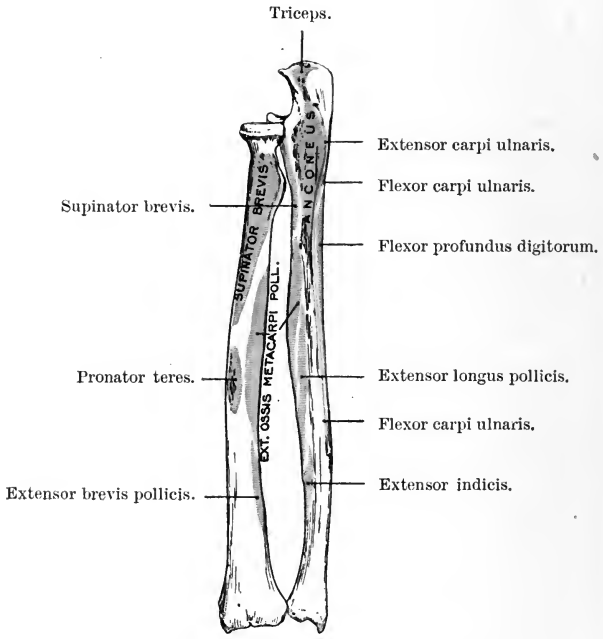


FIG. 36.—THE RADIUS AND ULNA FROM BEHIND.

and use. *Action.* It extends the little finger and moves back the wrist and elbow. As the inner piece of the split tendon is not united with the common extensor, it can straighten the digit during flexion of the other fingers.

Extensor carpi ulnaris: origin; insertion; The EXTENSOR CARPI ULNARIS MUSCLE (F) arises from the common tendon, the aponeurosis of the forearm, and an intermuscular septum on its outer side; it is also fixed by fascia to the middle third of the posterior border of the ulna below the anconeus muscle (fig. 36). Its tendon becomes free from fleshy fibres near the annular ligament, and passes through a separate sheath in that structure to be *inserted* into the tuberosity at the base of the metacarpal bone of the little finger.

Beneath this extensor are some of the muscles of the deep layer, with part of the ulna. On the outer side is the extensor of the little finger, with the posterior interosseous vessels. relations;

Action. The ulnar extensor straightens the wrist, and inclines the hand towards the ulnar side: it can then extend the elbow-joint. and use.

The ANCONEUS (G) is a small triangular muscle near the elbow. It *arises* from the outer condyle of the humerus by a tendon distinct from, and on the ulnar side of the common tendon of the foregoing muscles. From this origin the fibres diverge to their *insertion* into the outer side of the olecranon, and into the impression on the upper third of the posterior surface of the ulna (fig. 36). Anconeus origin; insertion;

The upper fibres are nearly transverse, and are contiguous to the lowest of the triceps muscle. Beneath the anconeus lie the supinator brevis muscle, and the interosseous recurrent vessels. touches the triceps;

Action. It assists the triceps in extending the elbow. use.

Dissection (fig. 37). For the display of the deep muscles of the back of the forearm, and of the posterior interosseous vessels and nerve, three of the superficial muscles, viz., extensor communis digitorum, extensor minimi digiti, and extensor carpi ulnaris, are to be divided above and turned aside; and the small branches of the nerve and artery entering these muscles may be cut. Dissection of deep layer of muscles,

The loose tissue and fat are then to be removed from the muscles, and from the ramifications of the artery and nerve; and a slender part of the nerve, which sinks beneath the extensor of the second phalanx of the thumb about the middle of the forearm, should be traced beyond the wrist. and interosseous vessels and nerve.

The deep muscles should be carefully separated, since the outer two of the thumb are not always very distinct from each other.

DEEP LAYER of MUSCLES (fig. 37). In this layer there are five muscles, viz., one supinator of the forearm, and four special extensor muscles of the thumb and index finger. The highest muscle, partly surrounding the upper third of the radius, is the supinator brevis (D). Below this are the three muscles of the thumb in the following order:—the extensor of the metacarpal bone (E), the extensor of the first (F), and that of the second phalanx (G). On the ulna the indicator muscle (H) is placed. Five muscles in the deep layer.

The EXTENSOR OSSIS METACARPI POLLICIS (E, fig. 37, also fig. 36) is the largest and highest of the extensor muscles of the thumb, and is sometimes united with the supinator brevis. It *arises* from the posterior surface of the radius in its middle third, below the supinator brevis, from a special narrow impression on the ulna, occupying the upper third of the outer division of the posterior surface, and from the intervening interosseous membrane. The tendon is directed outwards over the radial extensors of the wrist, and through the annular ligament, to be *inserted* into the base of the metacarpal bone of the thumb, and by a slip into the trapezium: another slip is frequently continued to the abductor pollicis. Extensor ossis metacarpi pollicis: origin; insertion;

The muscle is concealed at first by the common extensor of the fingers; but it becomes superficial in the lower third of the the muscle is at first deep, but

afterwards superficial:

use.

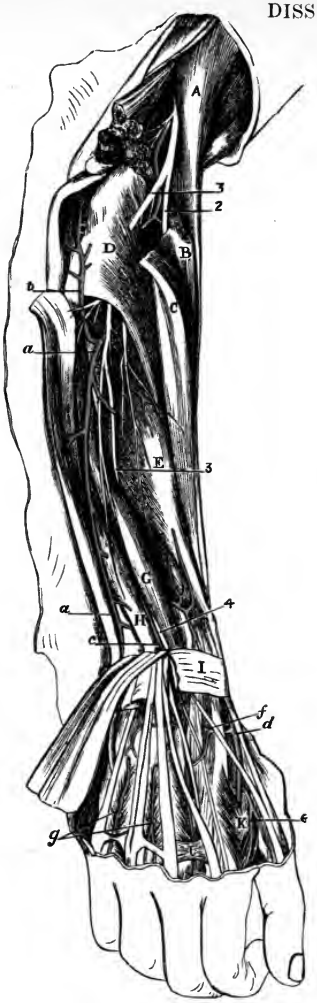
Extensor of first phalanx:

origin;

insertion

and use.

Extensor of second phalanx:



forearm between the last muscle and the radial extensors of the wrist (fig. 35). Opposite the carpus the radial artery winds backwards beneath its tendon. Between the contiguous borders of this muscle and the supinator brevis the posterior interosseous artery (*a*) appears.

Action. By this muscle the thumb is carried outwards and backwards from the palm of the hand, and the hand is moved to the radial side.

The EXTENSOR BREVIS POLLICIS (ext. primi internodii poll.; F; fig. 35, I.) is the smallest muscle of the deep layer, and its tendon accompanies that of the preceding extensor. Its *origin*, about one inch in width, is from the radius and the interosseous membrane, close below the attachment of the last muscle (fig. 36). The tendon passes through the same space in the annular ligament as the extensor of the metacarpal bone, and is *inserted* into the base of the first phalanx of the thumb. With respect to surrounding parts, this muscle has similar relations to the preceding.

Action. It extends first the proximal phalanx and then the metacarpal bone, like its companion.

The EXTENSOR LONGUS POLLICIS (ext. secundi internodii poll.; G)

FIG. 37.—DEEP DISSECTION OF THE BACK OF THE FOREARM (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Supinator longus.
B. and C. Radial extensors of the carpus, cut.
D. Supinator brevis.
E. Extensor ossis metacarpi pollicis.
F. Extensor brevis pollicis.
G. Extensor longus pollicis.
H. Extensor indicis.
I. Posterior annular ligament.

Arteries:

a. Posterior interosseous.
b. Interosseous recurrent.
c. Ending of the anterior interosseous.
d. Radial.
e. Dorsal branches to the thumb and forefinger.
f. Dorsal carpal arch.
g. Two dorsal interosseous of the hand.

Nerves:

2. Radial.
3. Posterior interosseous at its origin, and
4. Near its ending on the back of the carpus.

arises from the middle third or more of the ulna below the anconeus, along the ulnar side of the extensor of the metacarpal bone (fig. 36); and from the interosseous membrane below, for about an inch. Its tendon, passing through a distinct sheath in the annular ligament, deeply grooving the radius, is directed along the dorsum of the thumb to be *inserted* into the base of the last phalanx. origin; insertion;

The belly of the muscle is covered by the extensor carpi ulnaris and the extensors of the fingers, but the tendon becomes superficial close to the wrist. Below the annular ligament its tendon crosses the extensors of the wrist and the radial artery. relations;

Action. It first extends both phalanges of the thumb, and then helps in moving backwards the metacarpal bone and the hand. and use.

The EXTENSOR INDICIS (indicator; H) *arises* on the inner side of the last muscle from the ulna for two or three inches (fig. 36), usually below the middle and from the lower part of the interosseous membrane. Near the wrist the tendon becomes free from muscular fibres, and passing beneath the annular ligament with the common extensor of the fingers, is applied to, and blends with the external tendon of that muscle in the expansion on the first phalanx of the forefinger. Indicator muscle: origin; insertion;

Until this muscle has passed the ligament it is covered by the superficial layer, but it is afterwards subaponeurotic.

Action. The muscle can point the forefinger, even when the three inner fingers are bent; and it will help the common extensor of the digits in drawing back the hand. and use.

Dissection. To lay bare the supinator brevis, it will be necessary to detach the anconeus from the external condyle of the humerus, and to cut through the supinator longus and the radial extensors of the wrist. After those muscles have been divided, the fleshy fibres of the supinator are to be followed forwards to their insertion into the radius; and that part of the origin of the flexor profundus digitorum which lies on the outer side of the insertion of the brachialis anticus, is to be removed. Dissection of supinator brevis.

The SUPINATOR BREVIS (D) surrounds the upper part of the radius, except at the tuberosity and the front of the bone below it. It arises from the external margin of the ulna for a distance of two inches, as well as from a depression below the small sigmoid cavity; also from the orbicular ligament of the radius and the external lateral ligament of the elbow-joint. The fibres pass outwards and forwards, and are *inserted* into the upper third or more of the radius, except at the fore and inner parts, reaching downwards to the insertion of the pronator teres, and forwards to the oblique line of the bone (fig. 25, p. 61; and fig. 36). Origin of short supinator; and insertion;

The supinator brevis is concealed altogether at the posterior and external aspects of the limb by the muscles of the superficial layer; and anteriorly the radial vessels and nerve lie over it. The lower border is contiguous to the extensor ossis metacarpi pollicis, only the posterior interosseous vessels (*a*) intervening. Through the overlying and contiguous parts;

substance of the muscle the posterior interosseous nerve (3) winds to the back of the limb.

use. *Action.* When the radius has been moved over the ulna in pronation, the short supinator comes into play to bring that bone again to the outer side of the ulna.

Posterior interosseous artery

The POSTERIOR INTEROSSEOUS ARTERY (fig. 37, *a*) is an offset from the common interosseous trunk (p. 66), and reaches the back of the forearm above the membrane between the bones. Appearing between the contiguous borders of the supinator brevis and extensor ossis metacarpi pollicis, the artery descends at first between the superficial and deep layers of muscles; and afterwards with a superficial position in the lower third of the forearm, along the tendon of the extensor carpi ulnaris as far as the wrist, where it ends by anastomosing with the carpal and anterior interosseous arteries. It furnishes *muscular offsets* to the surrounding muscles, and the following recurrent branch:—

between the layers of muscles,

and superficial:

its recurrent branch.

The *recurrent branch* (*b*) springs from the artery near the beginning, and ascends on or through the fibres of the supinator, but beneath the anconeus, to supply both those muscles and the elbow-joint; it anastomoses with the superior profunda artery and the recurrent radial (fig. 19, p. 46).

Posterior interosseous nerve:

The POSTERIOR INTEROSSEOUS NERVE (3) is derived from the musculo-spiral trunk (p. 53), and winds backwards through the fibres of the supinator brevis. Issuing from the supinator, the nerve is placed between the superficial and deep layers of muscles as far as the middle of the forearm. Much reduced in size at that spot, it sinks beneath the extensor of the second phalanx of the thumb, and runs on the interosseous membrane to the back of the carpus. Finally, the nerve enlarges beneath the tendons of the extensor communis digitorum, and terminates in filaments to the articulations of the carpus.

position to muscles;

termination on back of the carpus;

its muscular offsets.

Branches. It furnishes offsets to all the muscles of the deep layer, and to those of the superficial layer with the exception of the three following, viz., anconeus, supinator longus, and extensor carpi radialis longior.

Radial artery at wrist:

RADIAL ARTERY AT THE WRIST (fig. 37). The radial artery (*d*), with its venæ comites, winds below the radius to the back of the carpus, and enters the palm of the hand at the first interosseous space, between the heads of the first dorsal interosseous muscle. At first the vessel lies deeply on the external lateral ligament of the wrist-joint, and beneath the tendons of the extensors of the metacarpal bone and the first phalanx of the thumb; but afterwards it is more superficial, and is crossed by the tendon of the extensor of the second phalanx of the thumb.

relations to parts around,

and nerves.

Branches are small:

Offsets of the musculo-cutaneous nerve entwine around the artery (p. 56), and branches of the radial nerve are superficial to it. Its *branches* are numerous but inconsiderable in size:—

to back of carpus;

1. The *dorsal carpal branch* (*f*) passes transversely beneath the extensor tendons, and forms an arch (*the dorsal, or posterior, carpal arch*), with a corresponding offset of the ulnar artery; this arch is

joined by the interosseous arteries, especially by the posterior terminal branch of the anterior interosseous.

dorsal interosseous; From the dorsal carpal arch branches (*g*) descend to the third and fourth interosseous spaces, and constitute two of the three *dorsal interosseous arteries:* at the cleft of the fingers each divides into two, which are continued along the dorsum of the digits. Below, they communicate with the digital arteries; and above, they are joined by the perforating branches of the deep palmar arch.

metacarpal; 2. The *metacarpal* or *first dorsal interosseous branch* of the radial (fig. 35, *b*) gains the space between the second and third metacarpal bones, and receives, like the corresponding arteries of the other spaces, a perforating branch from the deep palmar arch. Finally, it is continued to the cleft of the fingers, where it joins the digital artery of the superficial palmar arch, and gives small dorsal branches to the index and middle fingers.

dorsal arteries of thumb 3. Two small *dorsal arteries of the thumb* arise opposite the metacarpal bone, along which they extend, one on each border, to be distributed on its posterior aspect.

and forefinger. 4. The *dorsal branch of the index finger* is distributed on the radial edge of that digit.

Sheaths of annular ligament The different divisions of the *annular ligament* may now be seen more completely by cutting the sheaths of the ligament over the several tendons passing beneath. There are six separate compartments, and each is lubricated by a synovial membrane. The most external one lodges the first two extensors of the thumb. The next is a large hollow for the two radial extensors of the wrist; and a small space for the long extensor of the thumb follows on the ulnar side. Farther to the inner side is the common sheath for the extensor of the fingers, and that of the forefinger; and then comes a slender compartment for the extensor of the little finger. Internal to all is the space for the extensor carpi ulnaris. The last muscle grooves the ulna; but the others lie in hollows in the radius in the order mentioned above, with the exception of the extensor minimi digiti which is situate between the bones.

from without inwards.

Bones grooved by the tendons.

Dissection. If the supinator brevis be divided by a vertical incision, and reflected from the radius, its attachment to that bone will be better understood.

To see insertion of supinator,

The posterior interosseous nerve, and the offsets from its ganglioform enlargement, may be traced more completely after the tendons of the extensor of the fingers and indicator muscle have been cut at the wrist.

interosseous nerve,

The posterior surface of the dorsal interosseous muscles of the hand may next be cleaned, so that their double origin, and their insertion into the side, and on the dorsum of the phalanges, may be fully observed. Between the heads of origin of these muscles the posterior perforating arteries appear.

and interosseous muscles.

Lastly, the outer head of the first dorsal interosseous muscle is to be divided, and carefully separated from the first metacarpal bone, so as to display the passage of the radial artery into the palm.

Passage of radial artery into palm.

Section VII.

LIGAMENTS OF THE SHOULDER, ELBOW, WRIST, AND HAND.

Directions. *Directions.* The ligaments of the remaining articulations of the limb, which are still moist, may be examined at once ; but if any of them have become dry, they may be softened by immersion in water, or with a wet cloth, while the student learns the others.

Dissection of external ligaments of shoulder. **Dissection.** For the preparation of the external ligaments of the shoulder-joint the tendons of the surrounding muscles, viz., subscapularis, supraspinatus, infraspinatus, and teres minor, must be detached from the capsule ; and as these are closely united with the capsule some care will be needed not to injure it.

Shoulder-joint, outline of. The Shoulder-Joint. This ball and socket joint (fig. 38) is formed between the head of the humerus and the glenoid fossa of the scapula. Enclosing the articular ends of the bones is a fibrous capsule lined by a synovial membrane. A ligamentous band (glenoid ligament) deepens the shallow scapular cavity for the reception of the large head of the humerus.

Looseness. The bones are but slightly bound together by ligaments, for, on the removal of the muscles, the head of the humerus may be drawn from the scapula for the distance of an inch.

Capsular ligament: The *capsular ligament* (fig. 14, [5], p. 36) encloses the articular portions of the bones. It is much thickened above, and is thin below. The surrounding tendons are closely adherent to it above, in front and behind.

attachments ; By the one end it is fixed around the articular surface of the scapula, where it is connected with the long head of the triceps. By the other the ligament is fixed (fig. 38) to the neck of the humerus close to the articular surface above, but at a little distance down the bone below ; and its attachment is interrupted between the tuberosities (*b*) by the tendon of the biceps muscle, across which fibres are continued, covering in the groove (fig. 14).

aperture ; On the inner side there is an aperture in the capsule, below the coracoid process, through which the synovial membrane of the joint is continuous with the bursa beneath the tendon of the subscapularis.

muscles around ; The following muscles surround the articulation ;—above and behind are the supraspinatus, infraspinatus, and teres minor ; below are the long head of the triceps and the lower part of the subscapularis ; and in front it is covered by the last-named muscle.

accessory band. On the upper part of the capsule is a thick band of fibres—the *coraco-humeral* or *accessory ligament* (fig. 14, [8]), which springs from the outer side of the coracoid process of the scapula, and widening over the top of the joint, is attached to the great tuberosity and margins of the bicipital groove.

Dissection of internal structures. **Dissection.** To see the interior of the articulation cut away the posterior part of the capsule, leaving its attachments to the humerus

and scapula, dislocate the head of the humerus through the hole thus made and saw it off close to the capsular attachment. When this has been done, the *glenoid ligament*, the *tendon of the biceps* and the *gleno-humeral bands* on the articular aspect of the front part of the capsule will be manifest.

Tendon of the biceps.

The *tendon of the biceps muscle* arches over the head of the humerus, and serves the purpose of a ligament in supporting the bone. It is attached to the upper part of the head of the scapula (fig. 38, *d*), and is united on each side with the glenoid ligament. At first flat, it afterwards becomes round, and enters the groove between the tuberosities of the humerus, where it is surrounded by the synovial membrane. The transverse fibres bridging across the bicipital groove are spoken of as the *transverse humeral* ligament.

Transverse humeral ligament.

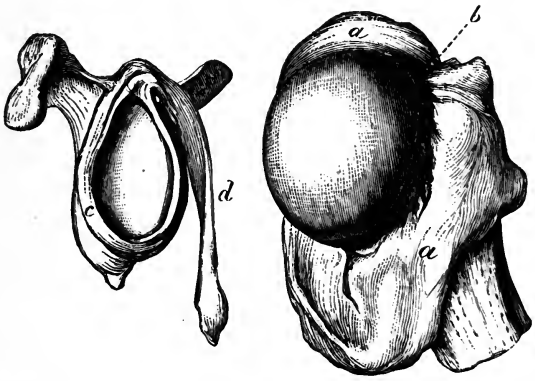


FIG. 38.—VIEW OF THE INTERIOR OF THE SHOULDER-JOINT.

a. Attachment of the capsule to the neck of the humerus.
b. Interval of the bicipital groove.
c. Glenoid ligament around the glenoid fossa.
d. Tendon of the long head of the biceps fixed at the top of the fossa.

Glenoid ligament.

The *glenoid ligament* (fig. 38, *c*) is a narrow fibrous band, which surrounds the fossa of the same name, increasing it for the reception of the head of the humerus. It is connected in part with the sides of the tendon of the biceps; but most of its fibres are fixed separately to the margin of the glenoid fossa.

The *gleno-humeral ligaments* are three bands, or folds, seen on the articular aspect of the fore part of the capsule. The *superior* is exposed by cutting away the biceps tendon in the joint, and appears as a small fold along the inner border of the tendon. The *middle* one springs from the margin of the glenoid cavity below the foregoing and passes obliquely downwards below the tendon of the subscapularis to the lesser tuberosity of the humerus, and the *inferior* is a strong band parallel with and below the middle, passing to the humerus between the attachments of the subscapularis and teres minor muscles.

Synovial membrane.

The *synovial membrane* lines the articular surface of the capsule, and is continued through the aperture on the inner side to join the bursa beneath the subscapular muscle. The membrane is reflected around the tendon of the biceps, and lines the upper part of the bicipital groove of the humerus.

Surface of humerus;

Articular surfaces (fig. 38). The convex articular head of the humerus is about three times as large as the hollow of the scapula, and forms rather less than the half of a sphere. The head of the bone is supported on a short neck, which is joined to the shaft at an obtuse angle.

of scapula.

The glenoid fossa of the scapula is oval in form with the larger end down, and is very shallow. Its margin is slightly more prominent below than above.

Kinds of movement.

Movements. The looseness of the capsule, the shallowness of the glenoid cavity and its smallness as compared with the extent of the articulating head of the humerus allow of the movements of this joint being both free and extensive. There is the common angular motion in four directions, with the circular or circumductory; and in addition a movement of rotation.

Flexion and extension are accompanied by rotation of scapula.

In the swinging to and fro movement, the carrying forwards and inwards of the humerus constitutes *flexion;* and the moving it backwards and outwards, *extension.* Flexion is freer than extension, as the scapula follows the humerus, undergoing a rotation upwards, so that the whole range of movement of the arm in this direction is much greater than that taking place in the reverse articulation. In extension the scapula is similarly rotated downwards, the lower angle approaching the vertebral column.

Checks to movements.

Flexion of the humerus upon the scapula is checked by the twisting of the capsule, and by the meeting of the small tuberosity of the former bone with the coraco-acromial arch. Extension is limited mainly by the coraco-humeral ligament.

Abduction and adduction. In abduction, the arm is moved outwards away from the body; and in adduction, it is brought downwards to the side. These movements, like the foregoing, are accompanied, and their range is increased by rotation of the scapula.

Abduction.

When the limb is abducted, the head of the humerus glides downwards in the glenoid cavity, and projects beyond it against the lower part of the capsule, which is stretched; while the great tuberosity sinks beneath the acromial arch, which sets a limit to the movement. In this condition a little more movement down of the head, either by muscles depressing it or by force elevating the farther end of the bone, will throw it out of place, giving rise to dislocation.

Adduction.

In adduction, the head of the humerus rises in the socket, and the coraco-humeral ligament being tightened checks the movement.

Circumduction.

In *circumduction*, the humerus passes in succession through the four different states above mentioned, and the limb describes a cone, the apex of which is at the shoulder and the base at the digits.

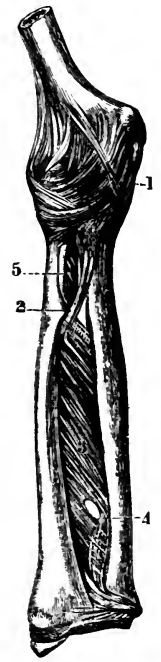
Rotation. There are two kinds of rotatory movement, viz., in and out; and in each the humerus revolves around an axis passing from the centre of the head through the shaft to the lower end of the bone. Rotation;

In rotation in, the great tuberosity moves forwards and inwards, the head of the bone glides backwards in the glenoid cavity, and the hinder part of the capsule is rendered tense. In rotation out, the movements of the parts of the humerus are reversed, and the front of the capsule is stretched. The movements are stopped by the tightening of the capsule, assisted by the muscles on the back and front of the joint respectively. in, and out.

THE ELBOW-JOINT.

Dissection. To make the necessary dissection of the ligaments of the elbow, the brachialis anticus must be taken away from the front, and the triceps from the back of the joint. The muscles connected with the outer and inner condyles of the humerus, as well as the supinator brevis and the flexor profundus digitorum, are to be removed. With a little cleaning the four ligaments — anterior, posterior, and two lateral—will come into view.

The interosseous membrane between the bones of the forearm will also be prepared by the removal of the muscles on both surfaces.



Dissection of the elbow-joint.

THE ELBOW-JOINT (fig. 39). In this articulation the lower end of the humerus is received into the hollow of the ulna, so as to produce a hinge-like arrangement; and the upper end of the radius assists to form the outer part of the joint. Where the bones touch, the surfaces are covered with cartilage; and they are united by the following ligaments :—

FIG. 39.—THE LIGAMENTS OF THE ELBOW-JOINT, AND OF THE RADIUS AND ULNA (BOURGERY). Bones forming the elbow-joint.

1. Capsule of the elbow-joint.
2. Oblique ligament.
3. Interosseous membrane.
4. Aperture for blood-vessels.
5. Tendon of the biceps.

The *external lateral ligament* is a roundish fasciculus, which is attached by one end to a depression below the outer condyle of the humerus, and by the other to the orbicular ligament round the head of the radius. A few of the posterior fibres pass backwards to the external margin of the olecranon. External lateral ligament.

The *internal lateral ligament* is triangular in shape. It is pointed at its upper extremity, and is connected to the inner condyle of Internal lateral ligament.

the humerus. The fibres diverge, and are inserted in this way :— The anterior, which are the strongest, are fixed to the edge of the coronoid process ; the posterior are attached to the side of the olecranon ; and a few middle fibres join a band passing transversely over the notch between the olecranon and the coronoid process. The ulnar nerve is in contact with the ligament ; and vessels enter the joint by the aperture beneath the transverse band.

Anterior ligament.

The *anterior ligament* is thin, and its fibres are separated by intervals in which masses of fat are lodged. By its upper edge the ligament is attached to the front of the humerus, and by its lower to the front of the coronoid process and the orbicular ligament of the radius. The brachialis anticus muscle covers it.

Posterior ligament.

The *posterior ligament* is much thinner and looser than the anterior, and is covered completely by the triceps muscle.

Superiorly it is attached to the humerus above the fossa for the olecranon ; and inferiorly it is inserted into the olecranon. Some few fibres are transverse between the margins of the fossa before mentioned.

Dissection.

Dissection. Open the joint by an incision across the front near the humerus, and disarticulate the bones, in order that the articular surfaces may be seen.

Synovial membrane.

The *synovial membrane* of the joint passes from one bone to another along the deep surface of the connecting ligaments. It is continued downwards on the inner surface of the orbicular ligament, and serves for the joint of the head of the radius with the small sigmoid cavity of the ulna.

Lower end of the humerus:

Articular surfaces. The articular surface of the lower end of the humerus is divided into two parts for the bones of the forearm. That for the radius, on the outer side, forms a rounded eminence

two articular surfaces,

(capitellum) which is confined to the front of the bone. The surface in contact with the ulna (trochlea) is limited internally and externally by a prominence, and hollowed out in the centre.

and three fossæ.

On the front of the humerus above the articular surface are two depressions which receive the coronoid process of the ulna and the head of the radius during flexion of the joint; and on the posterior aspect is a large fossa for the reception of the olecranon in extension of the joint.

Upper end of the ulna.

On the end of the ulna the articular surface of the great sigmoid cavity is narrowed in the centre, but expanded above and below (fig. 40). A median ridge, which is received into the hollow of the trochlea, extends from the upper to the lower end of the fossa ; and across the bottom of the cavity the cartilage is wanting over a small space between the coronoid and olecranon processes.

Head of the radius.

The head of the radius presents a circular depression with a raised margin, which plays over the capitellum of the humerus.

Kinds of motion :

Movement. This joint is like a hinge in its movements, permitting only flexion and extension.

bending;

In *flexion*, the bones of the forearm move forwards, each on its own articular surface, so as to leave the back of the humerus uncovered. The movement is checked by the meeting of the arm

and forearm; and the posterior and internal lateral ligaments are stretched.

In *extension*, the ulna and radius move on the articular surface of the humerus until they come into a line with the arm-bone. This movement is checked by the anterior ligament, and the muscles on the front of the joint. extending.

Union of the Radius and Ulna. The radius is connected with the ulna at both ends by means of synovial joints and surrounding ligaments; and the shafts of the bones are united by interosseous ligaments. Radius is joined to ulna

Upper radio-ulnar articulation. In this joint the head of the radius is received into the small sigmoid cavity of the ulna, and is kept in place by the following ligamentous band:— at the upper end by

The *annular* or *orbicular ligament* (fig. 40, *a*) is about one-third of an inch wide, and is stronger behind than before; it is placed around the prominence of the head of the radius, and is attached to the anterior and posterior edges of the small sigmoid cavity of the ulna. Its upper border, the thicker, is connected with the ligaments of the elbow-joint; but the lower is free, and is applied around the neck of the radius. In the socket formed by this ligament and the cavity of the ulna the radius moves freely. orbicular ligament around the head of the bone;

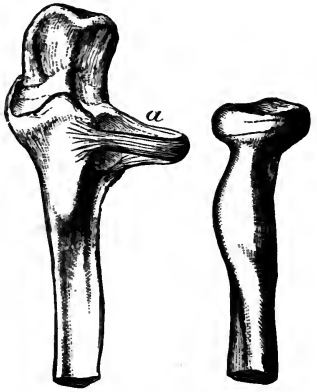


Fig. 40.—View of the Orbicular Ligament (*a*), which retains the Upper End of the Radius against the Ulna.

The *synovial membrane* is a prolongation of that lining the elbow-joint; it projects inferiorly between the neck of the radius and the lower margin of the annular ligament. synovial membrane.

Ligaments of the shafts of the bones. The aponeurotic stratum connecting together the bones nearly their whole length consists of the two following parts:— Union of the shafts:

The *interosseous membrane* (fig. 39, [3]) is a thin fibrous layer, which is attached to the contiguous margins of the radius and ulna, and forms an incomplete septum between the muscles on the front and back of the forearm. Most of its fibres are directed obliquely downwards and inwards, though a few on the posterior surface have an opposite direction. Superiorly, the membrane is wanting for a considerable space, and through the interval the posterior interosseous vessels pass backwards. Some small apertures exist in it for the passage of vessels; and the largest of these ([4]) is about two inches from the lower end, through which the anterior interosseous artery turns to the back of the wrist. The membrane gives attachment to the deep muscles. interosseous membrane is deficient above;

oblique ligament.

The *oblique ligament* (fig. 39, [2]) is a slender band above the interosseous membrane, the fibres of which have a direction opposite to those of the membrane. By one end it is fixed to the lower end of the coronoid process, and by the other to the radius below the tuberosity. The ligament divides into two the space above the interosseous membrane. Oftentimes this band is not to be recognised.

The lower end after.

The lower radio-ulnar articulation cannot be well seen till after the examination of the wrist-joint.

Kind of motion of radius:

Movement of the radius. The radius moves forwards and backwards upon the ulna. The forward motion, directing the palm of the hand backwards, is called pronation; and the backward movement, by which the palm of the hand is turned to the front, is named supination.

pronation,

In *pronation*, the upper end of the bone rotates within the band of the orbicular ligament without shifting its position to the ulna. The lower end, on the contrary, moves over the ulna from the outer to the inner side, describing nearly half a circle; and the shaft crosses obliquely that of the ulna.

supination;

In *supination*, the lower end of the radius turns backwards over the ulna; the shafts come to be placed side by side, the radius being external; and the upper end rotates from within out in its circular band.

axis of motion;

In these movements the radius revolves round an axis, internal to the shaft, which is prolonged upwards through the neck and head of the bone, and downwards through the styloid process of the ulna.

use of ligaments;

The upper end of the bone is kept in place by the orbicular ligament; the lower end by the triangular fibro-cartilage; and the shafts are united by the interosseous ligament, which is tightened in supination, and relaxed in pronation.

in fracture motion ceases.

In fracture of either bone the movements cease; in the one case because the radius cannot be moved unless it is entire; and in the other because the broken ulna cannot support the revolving radius.

THE WRIST-JOINT.

Dissection.

Dissection. To see the ligaments of the wrist-joint, the tendons and the annular ligaments must be removed from both the front and back; and the fibrous structures and the small vessels should be taken from the surface of the ligaments.

Bones forming wrist-joint united by

THE WRIST-JOINT (radio-carpal articulation; fig. 41). The lower end of the radius, and the first row of the carpal bones, except the pisiform, enter into this joint. Four ligaments connect the bones, viz., anterior and posterior, and two lateral. The ulna is shut out from the articulation by a piece of fibro-cartilage.

external lateral,

The *external lateral ligament* is a short band, which passes from the styloid process of the radius to the outer part of the scaphoid bone.

The *internal lateral ligament* is longer and thicker than the external. It is attached by one end to the styloid process of the ulna, and by the other to the rough upper part of the pyramidal bone. Some of the anterior fibres are continued to the pisiform bone. internal lateral,

The *anterior ligament* (fig. 41, 1) springs from the radius, and is inserted into the first row of carpal bones, except the pisiform on the anterior surface. anterior and

The *posterior ligament* (fig. 44, 1, p. 103) is membranous, like the anterior, and its fibres are directed downwards and inwards from the radius to the same three carpal bones on the posterior aspect. posterior ligaments.

Fig. 41.—Front View of the Articulations of the Wrist, and Carpal and Metacarpal Bones (Bourgery).

1. Anterior ligament of the wrist-joint.
2. Capsule of the joint of the metacarpal bone of the thumb with the trapezium.
3. Pisiform bone, with its ligamentous bands.
4. Transverse bands uniting the bases of the metacarpal bones.

Dissection. To see the form of the articular surfaces, the joint may be opened by a transverse incision through the posterior ligament, near the bones of the carpus. Dissection.

Articular surfaces. The end of the radius, and the fibro-cartilage (fig. 42, *c*) uniting it with the ulna form a shallow socket for the reception of the carpal bones; and the surface of the radius is divided by a prominent line into an external triangular, and an internal square impression. The three carpal bones of the first row constitute a convex eminence, which is received into the hollow before mentioned in this way: the scaphoid bone is opposite the external triangular mark of the radius; the semilunar bone touches the square impression and the greater part of the triangular fibro-cartilage; while the small articular surface of the pyramidal bone is in contact with the apex of the fibro-cartilage and the adjoining part of the capsule. Surface of radius; of first row of carpal bones: opposed surfaces.

The *synovial membrane* has the arrangement common to simple joints. This joint communicates occasionally with the lower radio-ulnar articulation by means of an aperture in the fibro-cartilage between the two. Synovial sac.

Movements. The principal movements taking place in the radio-carpal articulation are flexion and extension. Lateral motion occurs only to a limited extent. Kinds of motion:

Flexion and extension. In flexion the hand is moved forwards, while the carpus glides on the radius from before backwards, and flexion;

extension. projects behind, stretching the posterior ligament. In extension the hand is carried backwards, and the row of carpal bones moves in the opposite direction, viz., from behind forwards, so as to cause the anterior ligament to be tightened. The backward movement is not so free as the forward.

Lower ends of radius and ulna joined by

LOWER RADIO-ULNAR ARTICULATION. In this articulation the head of the ulna is received into the sigmoid cavity of the radius; —an arrangement just the opposite to that between the upper ends of the bones.

capsule,

The chief bond of union between the bones is a strong fibro-cartilage; but a *capsule*, consisting of scattered fibres, surrounds loosely the end of the ulna.

triangular fibro-cartilage:

attachments,

and relations.

The *triangular fibro-cartilage* (fig. 42, *c*) is placed transversely below the end of the ulna, and is thickest at its margins and apex. By its base the cartilage is fixed to the ridge which separates the carpal from the ulnar articulating surface of the radius; and by its apex to the styloid process of the ulna, and the depression at the root of that projection. Its margins are united with the contiguous anterior and posterior ligaments of the wrist-joint; and its surfaces enter into the radio-carpal and the lower radio-ulnar articulations. It serves to unite the radius and ulna, and to form part of the socket for the carpal bones. Occasionally it is perforated by an aperture.

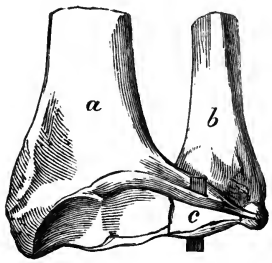


FIG. 42.—LOWER ENDS OF THE FOREARM BONES WITH THE UNITING FIBRO-CARTILAGE.

a. Radius. *b*. Ulna.
c. Triangular fibro-cartilage.

Synovial membrane.

The *synovial membrane* is very loose, and ascends between the radius and the ulna: it is separated from that of the wrist-joint by the triangular fibro-cartilage.

The motion in this articulation is referred to with the movements of the radius (p. 98).

Bones are joined into two rows.

UNION OF THE CARPAL BONES. The several bones of the carpus (except the pisiform) are united into two rows by small dorsal, palmar, and interosseous bands; and the two rows are connected together by wide separate ligaments.

Dissection of carpal

Dissection. The articulations of the carpal bones with each other will be prepared by taking away all the tendons from the hand, and cleaning carefully the connecting ligamentous bands. Two distinct ligaments from the pisiform bone to the unciform (*pisi-unciform*) and to the fifth metacarpal (*pisi-metacarpal*) are to be defined in the palm (p. 62).

and metacarpal joints.

At the same time the ligamentous bands uniting the metacarpal with the carpal bones, and with one another should be dissected.

How first row is united

BONES OF THE FIRST ROW (fig. 43). The semilunar bone is united to the scaphoid and pyramidal by *dorsal* (*d*) and *palmar*

transverse bands; as well as by small *interosseous ligaments* at the upper part of the contiguous surfaces.

The pisiform bone is articulated to the front of the pyramidal by a distinct *capsule* and *synovial sac*. It has further two special ligaments; one of these is attached to the process of the unciform, and the other to the base of the fifth metacarpal bone. Separate ligaments of pisiform bone.

The BONES OF THE SECOND ROW (fig. 43) are connected together in the same way as those of the first, viz., by a *dorsal* (*i*) and a *palmar* band of fibres from one bone to another. Between the contiguous rough surfaces of the several bones are *interosseous ligaments*, one in each interval. Second row is like first.

Movement. Only a small degree of gliding motion is permitted between the different carpal bones of each row, in consequence of the flattened articular surfaces, and the short ligaments uniting one to another; and this is less in the second than in the first row. A gliding movement.

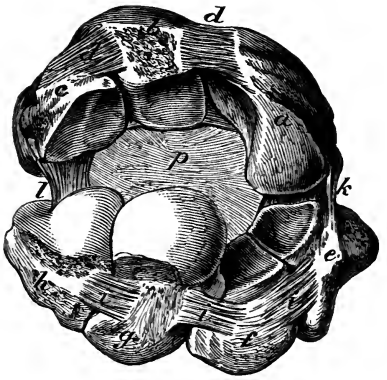


FIG. 43.—ARTICULATIONS OF THE CARPAL BONES, THE JOINT BETWEEN THE TWO ROWS BEING OPENED BEHIND.

a. Scaphoid bone.
b. Semilunar.
c. Pyramidal.
d. Dorsal transverse bands between those bones.
e. Trapezium.
f. Trapezoid.
g. Os magnum.
h. Unciform.
i. Dorsal transverse bands joining the bones.
k. External lateral ligament of the intercarpal joint.
l. Internal lateral ligament.
p. Anterior ligament.

ONE ROW WITH ANOTHER (transverse carpal joint; fig. 43). The two rows of carpal bones are connected by an anterior and posterior, and two lateral ligaments. Transverse carpal joint:

The *anterior ligament* (*p*) consists of strong fibres, which for the most part converge from the three bones of the first row to the os magnum. The anterior,

posterior ligament is thinner and looser; and its strongest fibres are transverse. posterior,

Of the *lateral ligaments* the *external* (*k*) is the better marked, and extends between the trapezium and scaphoid bones; the *internal* (*l*) passes from the pyramidal to the unciform bone. and lateral ligaments.

Dissection. After the division of the lateral and posterior ligaments, the one row of bones may be separated far enough from the other to allow the articular surfaces to be seen. Dissection.

Articular surfaces. The three bones of the first row, viz., scaphoid (*a*), semilunar (*b*), and pyramidal (*c*), together form an arch with its concavity turned downwards, while externally the scaphoid presents a convexity to the second row. The lower articular surface has a corresponding form, the os magnum and unciform Form of joint-surfaces.

making up a condyloid projection which is received into the arch of the first row, and the trapezium and trapezoid forming a slight hollow for the convexity of the scaphoid bone.

One synovial cavity for the carpal bones,

One *synovial sac* serves for the articulation of all the carpal bones, except the pisiform with the pyramidal. The cavity extends transversely between the two rows of the carpus, and is continued upwards and downwards between the individual bones. The offsets upwards are two, and they sometimes open into the cavity of the wrist-joint ; but the offsets in the opposite direction are three, and may be continued to all, or only to the two outer of the four inner carpo-metacarpal joints.

and some metacarpals.

Kinds of motion:

Movements. Owing to the irregular shape of the articular surfaces, only forward and backward movements are permitted in the transverse carpal joint.

flexion ;

Flexion. As the hand is brought forwards, the os magnum and unciform move backwards in the socket formed by the first row, while the trapezium and trapezoid advance over the scaphoid, and the posterior ligament is tightened.

extension.

Extension. The backward movement is freer than flexion. The trapezium and trapezoid glide backwards over the scaphoid, and the os magnum and unciform project on the palmar aspect, the movement being checked by the anterior ligament of the joint and the strong flexor tendons.

Combined movements of radio-carpal and transverse carpal joints ;

The axes upon which the movements of flexion and extension of the radio-carpal and transverse carpal joints take place are not strictly transverse, but oblique in opposite directions, that of the proximal articulation having its inner end directed forwards, while that of the distal articulation is inclined from without inwards and backwards. In order therefore to move the hand directly forwards

flexion and extension ;

or backwards, both joints are called into play simultaneously. By a combination of flexion in the one joint with extension in the other, lateral movements (*abduction* and *adduction*) of the hand are

abduction ;

produced. Thus, abduction results from flexion of the radio-carpal and extension of the transverse carpal articulation, and adduction,

adduction ;

which is the freer movement, from extension of the radio-carpal

and circumduction.

and flexion of the transverse carpal joint. In *circumduction* the hand passes successively through the several states of angular movement, describing a cone with the apex at the wrist, and the excursion is greater in the direction of flexion and adduction than in the opposite directions.

Metacarpal bones joined at bases,

Union of the Metacarpal Bones. The metacarpal bones of the four fingers are connected at their bases by the following ligaments :—A *dorsal* (fig. 44) and *palmar* (fig. 41) fasciculus of fibres passes transversely from each bone to the next ; and the bands in the palm are the strongest. Besides these, there is a short *interosseous ligament* between the contiguous rough surfaces of the bones.

with synovial joints,

Where the metacarpal bones touch they are covered by cartilage ; and between the articular surfaces there are prolongations of the synovial cavity serving for their articulation with the carpus.

and at heads.

At their distal ends the same four metacarpal bones are connected

by the *transverse ligament*, which was seen in the dissection of the hand (p. 81).

Union of the Metacarpal and Carpal Bones. The metacarpal bones of the fingers are articulated with the carpal bones after one plan ; but the bone of the thumb has a separate joint. Carpal and metacarpal joints.

The *metacarpal bone of the thumb* articulates with the trapezium ; and the ends of the bones are encased in a capsular ligament (fig. 41, 2), which is lined by a simple *synovial membrane*. That of the thumb.

Fig. 44.—Posterior Ligaments of the Wrist, and Carpal and Metacarpal Bones (Bourgery).

1. Posterior radio-carpal.
2. Carpo-metacarpal capsule of the thumb.
3, 3. Transverse bands between the bases of the metacarpal bones.

The thumb-joint possesses angular movement in opposite directions, with opposition and circumduction, thus :— Motion :

Flexion and extension. When the joint is flexed, the metacarpal bone is brought in front of the palm ; and as the movement proceeds, the thumb is gradually turned towards the fingers, passing into the state of *opposition*. In this way the thumb may be made to touch the palmar surface of any or all of the fingers, the phalanges of the latter being somewhat bent at the same time. Extension of the joint is very free, and by it the metacarpal bone is removed from the palm towards the outer border of the forearm. bending and opposition ; extending ;

Abduction and adduction. By these movements the thumb is placed in contact with, or removed from the forefinger. and lateral motion.

The *metacarpal bones of the fingers* receive longitudinal bands from the carpal bones on both aspects, thus :— Joints of fingers

The *dorsal ligaments* (fig. 44) are two to each, except to the bone of the little finger. The bands of the metacarpal bone of the forefinger come from the trapezium and trapezoid : those of the third metacarpal are attached to the trapezoid and os magnum ; the bone of the ring finger receives its bands from the os magnum and unciform ; and to the fifth metacarpal bone there is but one ligament from the unciform. have dorsal

The *palmar ligaments* (fig. 41), usually one to each metacarpal bone, are weaker and less constant than the dorsal. These ligaments may be oblique in direction ; and sometimes a band is divided between two, as in the case of a ligament passing from the trapezium to the second and third metacarpals. One or more may be wanting and palmar bands ;

lateral band. On the ulnar side of the metacarpal bone of the middle digit is a longitudinal *lateral band*, which is attached above to the os magnum and unciform, and below to a rough part on the inner side of the base of the above mentioned bone. Sometimes this band isolates the articulation of the last two metacarpals with the unciform bone from the remaining carpo-metacarpal joint; but more frequently it is divided into two parts, and does not form a complete partition.

This band may be seen by opening from behind the articulation between the unciform and the last two metacarpal bones; and by cutting through the transverse ligaments joining the third and fourth metacarpals so as to allow their separation.

Very little motion. *Movement.* Scarcely any appreciable antero-posterior movement exists in the articulations of the bases of the metacarpal bones of the fore and middle fingers; but in the ring and little fingers the motion is greater, with a slight degree of opposition.

Dissection. **Dissection.** The articular surfaces of the bones in the carpo-metacarpal articulation may be seen by cutting through the rest of the ligaments on the posterior aspect of the hand.

Articular surfaces, and contact. *Articular surfaces.* The metacarpal bone of the forefinger has a broad, notched articular surface, which receives the prominence of the trapezoid bone, and articulates laterally with the trapezium and os magnum. The middle finger metacarpal articulates with the os magnum. The metacarpal bone of the ring finger touches the unciform bone and the os magnum. And the little finger bone is opposed to the unciform.

Synovial sacs, two or three. *Synovial sacs.* Usually two synovial sacs are interposed between the carpal and metacarpal bones, viz., a separate one for the bone of the thumb, and offsets of the common carpal synovial sac (p. 102) for the others. Sometimes there is a distinct synovial sac for the articulation of the two inner metacarpals with the unciform bone.

Interosseous ligaments, metacarpal, and carpal. *Interosseous ligaments.* The interosseous ligaments between the bases of the metacarpal bones may be demonstrated by detaching one bone from another; and those uniting the adjacent carpal bones may be shown in the same way.

Metacarpo-phalangeal articulations; Union of Metacarpal Bone and First Phalanx (fig. 45). In this joint the convex head of the metacarpal bone is received into the glenoid fossa of the phalanx, and the two are united by the lateral, anterior and posterior ligaments.

Dissection of finger-joints. **Dissection.** For the examination of this joint it will be requisite to clear away the tendons and the tendinous expansion around it. A lateral ligament on each side, and an anterior thick band are to be defined. One of the joints may be opened to see the articular surfaces.

The same dissection may be made for the articulations between the phalanges of the fingers.

lateral ligaments; The *lateral ligaments* (*a*) are triangular in form; attached above to the lower part of the tubercle on the side of the head of the metacarpal bone, and below the phalanx and to the anterior ligament.

The *anterior ligament* (*b*) is a strong and dense band, which is fixed firmly to the phalanx, but loosely to the metacarpal bone. It is grooved for the flexor tendon; and to its sides the lateral ligaments are united. anterior ligament;

On the dorsal aspect of the joint, the capsule is completed by a thin layer of connective tissue which supports the synovial membrane, and is closely covered by the extensor tendon. The *synovial* membrane of the joint is a simple sac. posterior. Synovial sac.

In the articulation of the thumb two sesamoid bones are connected with the anterior ligament, and receive most of the fibres of the lateral ligaments. Joint of thumb.

Movements. Motion in four opposite directions, together with circumduction, take place in these condyloid joints. Kinds of motion:

Flexion and extension. In flexion, the phalanx glides forwards over the head of the metacarpal bone, and leaves this exposed to form the knuckle when the finger is shut. The lateral ligaments and the extensor tendon are put on the stretch as the joint is bent. In extension the anterior ligament and the flexor tendons are stretched, and limit the movement. bending;

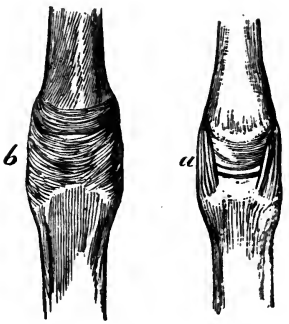


Fig. 45.

extending

Abduction and *adduction* are the lateral movements of the finger from or towards the middle line of the hand. The lateral ligament of the side of the joint which is rendered convex is tightened, and the other is relaxed. lateral motion;

The *circumductory* motion is less impeded in the fore and little fingers than in the others. In the joint of the thumb the movements, especially to the side, are much less extensive than in the fingers. circumductory.

Union of the Phalanges. The ligaments of these joints are similar to those in the metacarpo-phalangeal articulations, viz., two lateral, an anterior and a membranous posterior. Joints of the phalanges have

The *lateral ligaments* are triangular in form. Each is connected by its apex to the proximal phalanx at the side of the head; and by its base to the distal phalanx and the anterior ligament. lateral and

The *anterior ligament* has the same mode of attachment between the extremities of the bones as in the metacarpo-phalangeal joint, but it is not so strong. anterior ligaments.

There is a simple *synovial membrane* present in the joint. Synovial sac.

The joint of the second with the last phalanx is like the preceding in the number and disposition of its ligaments; but all the articular bands are much less strongly marked. Last joint.

Articular surfaces. The head of each phalanx is marked by a pulley-like surface. The base presents a hollow on each side of a median ridge, which fits into the central depression of the opposed articular surface. Surfaces of the bones.

Kinds of motion:

Movements. The two interphalangeal joints can be bent and straightened like a hinge.

bending,

Flexion and extension. In flexion, the distal phalanx moves round the proximal in each joint, and the motion is checked by the lateral ligaments and the extensor tendon: in the joint between the middle and the metacarpal phalanx this movement is most extensive. In extension the farther phalanx comes into a line with the nearer one, and the motion is stopped by the anterior ligament and the flexor tendons.

extending.

TABLE OF THE CHIEF ARTERIES OF THE UPPER LIMB.

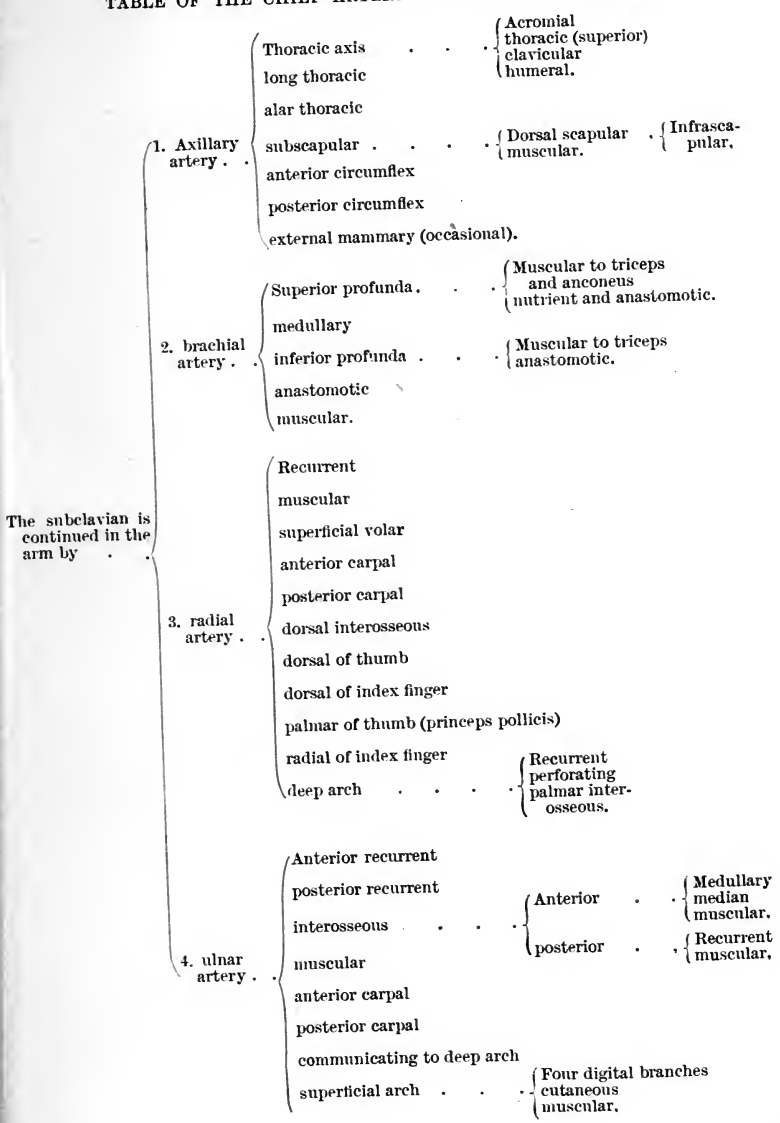


TABLE OF THE SPINAL NERVES OF THE UPPER LIMB.

- **Brachial Plexus gives off below the clavicle**
  - Anterior thoracic
    - External
    - internal.
  - subscapular
    - Superior
    - middle or long
    - inferior.
  - circumflex
    - Articular
    - cutaneous
    - to teres minor
    - to deltoid.
  - nerve of Wrisberg
  - internal cutaneous
    - cutaneous in arm
    - anterior of forearm
    - posterior of forearm.
  - musculo-cutaneous
    - To coraco-brachialis, biceps and brachialis anticus
    - external cutaneous of forearm
    - articular to carpus.
  - median
    - To pronator teres, flexor carpis radialis, palmaris longus, and flexor sublimis digitorum
    - anterior interosseous
      - To flexor longus pollicis
      - to flexor profundus digitorum in part
      - to pronator quadratus.
    - cutaneous palmar
    - to muscles of thumb in part
    - five digital branches.
  - ulnar
    - Articular to elbow
    - to flexor carpi ulnaris
    - to flexor profundus in part
    - cutaneous branch of forearm and palm
    - dorsal cutaneous of the hand
    - superficial palmar division
      - Communicating two digital branches
      - to palmaris brevis.
    - deep palmar nerve.
  - musculo-spiral
    - Internal cutaneous
    - to triceps and anconeus
    - external cutaneous, upper and lower
    - to supinator longus and extensor carpi radialis longior
    - posterior interosseous
      - Muscular
      - articular.
    - radial
      - Cutaneous of back of hand, of thumb, of index and middle fingers and half the ring.

CHAPTER III.

DISSECTION OF THE LOWER LIMB.

SECTION I.

THE BUTTOCK, OR THE GLUTEAL REGION.

Directions.

Directions. Both this SECTION and the following one are to be completed by the student in the four days appointed for the body to lie in the prone position, and the student who is commencing his work in practical anatomy by the dissection of the lower limb should read the *general directions* for the beginner on p. 1 before proceeding with this section.

Position of the body.

Position. During the dissection of the back of the thigh the body is placed with the face down and the pelvis is to be well raised by blocks.

Surface-marking.

Surface marking. At the upper part of the buttock, by exercising deep pressure, the student will make out the crest of the iliac bone, and on tracing this inwards the posterior superior iliac spine will be felt opposite the second sacral spine; and this part marks the middle of the sacro-iliac joint. Internally the lower part of the sacrum and the coccyx will be found at the bottom of the natal furrow. Inferiorly, the thick fold of the nates is very evident, and above this the mass of the gluteus maximus muscle contributes largely to the prominence of the buttock. About three or four inches below the anterior part of the iliac crest on the outer side of the thigh is the great trochanter of the femur, and by pressing upwards beneath the inner part of the fold of the nates the tuberosity of the ischium can be felt. A line (Nelaton's) drawn from the anterior superior iliac spine to the most prominent part of the ischial tuberosity passes just over the highest part of the great trochanter and is used in surgery for ascertaining the degree of displacement of that part of the bone in various conditions.

Take up the skin:

Dissection. The integument is to be raised from the buttock by means of the following incisions (fig. 1, A, p. 3)—One is to be made along the whole length of the iliac crest, and continued in the middle line of the sacrum to the tip of the coccyx (G). Another is to be begun where the first terminates, and is to be carried outwards and downwards across the thigh, ending about six inches

below the great trochanter (H). The flap of skin thus marked out is to be thrown forwards.

seek cutaneous nerves on the crest

Many of the cutaneous nerves of this region will be found in the fat along the line of the iliac crest (fig. 46). Thus, in front, but rather below the crest, are branches of the external cutaneous. Crossing the crest towards the fore part is a large offset of the last dorsal nerve ; and usually farther back, but close to the bone, a smaller branch from the ilio-hypogastric nerve. At the outer border of the erector spinæ are two or three branches of the lumbar nerves.

and by side of sacrum:

By the side of the sacrum and coccyx two or three offsets of the sacral nerves are to be looked for beneath the fat.

other nerves of small sciatic below:

The remaining cutaneous nerves are derived from the small sciatic, and must be sought beneath the fat along the line of the lower incision, where they come from underneath the gluteus maximus. Some turn upwards over that muscle, and others are directed down the thigh.

cutaneous arteries.

Cutaneous arteries accompany all the nerves, and will serve as guides to their situation.

Sources of the cutaneous nerves:

CUTANEOUS NERVES (fig. 46, also fig. 2, p. 4). The nerves distributed in the integuments of the buttock are small but numerous, and are derived from the last dorsal nerve, from branches of the lumbar and sacral plexuses, and from the posterior primary divisions of the lumbar and sacral nerves.

from last dorsal;

The LAST DORSAL NERVE (fig. 46) (8) supplies the buttock by means of its lateral cutaneous branch. This offset perforates the muscles of the abdomen, and crosses the front of the iliac crest to be distributed over the fore part of the gluteal region, as low as the great trochanter.

from lumbar plexus,

NERVES OF THE LUMBAR PLEXUS. Parts of two nerves of the plexus of the lumbar nerves, viz., ilio-hypogastric from the first, and the external cutaneous from the second and third, are spent in the integuments of this region.

through ilio-hypogastric, and

The *iliac branch of the ilio-hypogastric* (7) crosses the iliac crest in front of the lumbar nerves, lying in a groove in the bone, and extends generally only a short distance below the crest.

external cutaneous;

Offsets of the posterior branch of the *external cutaneous nerve* of the thigh bend backwards to the integuments above the great trochanter, and cross the ramifications of the last dorsal nerve (see fig. 2, p. 4).

from posterior branches of lumbar

POSTERIOR PRIMARY BRANCHES. The offsets of the posterior primary pieces of the *lumbar nerves* (6) are two or three in number, and cross the crest of the ilium at the outer edge of the erector spinæ ; they ramify in the integuments of the middle of the buttock, and some branches may be traced nearly to the great trochanter.

and sacral nerves;

The branches of the *sacral nerves* (5) perforate the gluteus maximus near the sacrum and coccyx, and are then directed outwards for a short distance in the integuments over the muscle. These offsets are usually two in number : the largest is opposite the lower end of the sacrum, and the other by the side of the coccyx.

SMALL SCIATIC (1). This nerve of the sacral plexus sends superficial branches to the buttock. Its cutaneous offsets appear along from sacral plexus,

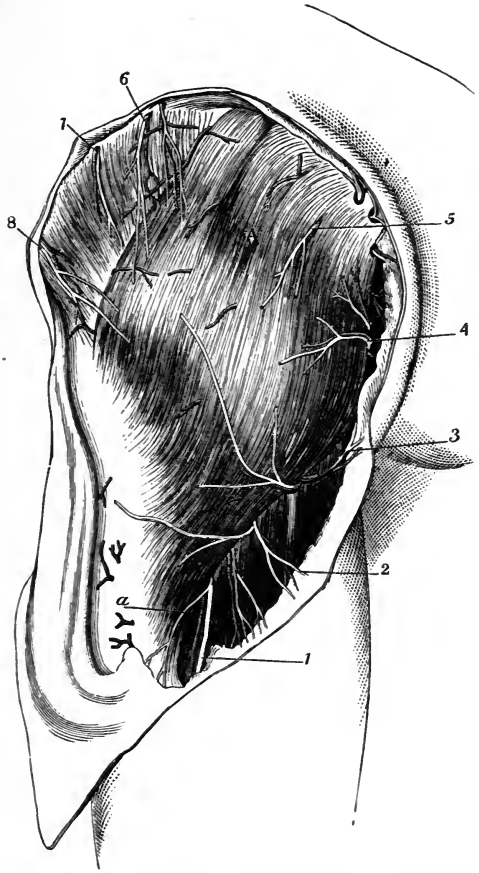


FIG. 46.—SUPERFICIAL VIEW OF THE BUTTOCK OF THE LEFT SIDE (ILLUSTRATIONS OF DISSECTIONS).

A. Gluteus maximus muscle, with the gluteus medius projecting above it.
a. Continuation of sciatic artery along the back of the thigh.

Nerves:

1. Small sciatic trunk.
2. Its cutaneous thigh branches.
3. Inferior pudendal.
4. Branches of perforating cutaneous.
5. Cutaneous of the sacral.
6. Posterior branches of the lumbar nerves.
7. Ilio-hypogastric.
8. Last dorsal.

the lower border of the gluteus maximus, accompanied by superficial branches of the sciatic artery; two or three ascend round the edge of the muscle, and are lost in the integuments of the lower through small sciatic,

part of the buttock; the remaining branches ([2]) descend to the thigh, and will be afterwards noticed on it (p. 130).

and perforating cutaneous branch.

The PERFORATING CUTANEOUS NERVE of the sacral plexus ([4]) turns round the edge of the gluteus maximus near the coccyx, and supplies the skin of the adjacent part of the buttock: this nerve has been exposed in the dissection of the perineum.

Clean gluteus maximus;

Dissection. The thin and unimportant deep fascia of this region may be disregarded, in order that the great gluteal muscle, which is one of the most difficult in the body to clean, may be well displayed. To lay bare the muscle, let the student turn aside the cutaneous nerves, and adduct and rotate inwards the limb to make tense the muscular fibres. Having cut through the fat and fascia from the origin to the insertion, let him carry the scalpel along one bundle of fibres at a time in the direction of a line from the sacrum to the femur, until all the coarse fasciculi are cleaned. If the student has a right limb, it will be more convenient to begin the dissection at the upper border; but if a left limb, at the lower margin of the muscle.

mode of proceeding.

Fascia of the buttock.

The *fascia of the buttock* is a prolongation of that enveloping the thigh, and is fixed to the crest of the ilium, and to the sacrum and coccyx. It is much thicker in front of, than on the gluteus maximus, and gives attachment superiorly to the gluteus medius, which it covers; in this place, indeed, the student often has some difficulty in defining the edge of the greater gluteus, since at the edge of the muscle the fascia splits to encase it.

Gluteus maximus:

origin;

The GLUTEUS MAXIMUS (fig. 46, A) is the most superficial muscle of the buttock, and reaches from the pelvis to the upper part of the femur. Its *origin* from the pelvis is fleshy, and is connected with bone and with aponeurosis:—Thus, the muscle is attached, from above down, to the posterior fourth of the iliac crest, and to a special impression on the hip-bone above the superior curved line (fig. 47); next, to the aponeurosis of the erector spinæ muscle; then to the back of the fourth and fifth pieces of the sacrum, and the back of the coccyx; and lastly, to the back of the whole length of the great sacro-sciatic ligament. From this extensive origin the fibres are directed downwards and outwards to

insertion;

their *insertion*:—The whole of the upper half of the muscle, and a few superficial fibres of the lower half are inserted into the strong fascia lata (ilio-tibial band) of the outer side of the thigh; and the remainder are fixed into the rough line (gluteal ridge) leading from the linea aspera to the great trochanter of the femur (fig. 61, p. 158).

relations of the surfaces,

and borders;

The gluteus forms the prominence of the buttock, and resembles the deltoid muscle of the arm in its situation and in the coarseness of its texture. Its cutaneous surface is covered by the common integuments and the investing fascia of the limb, and by the superficial nerves and vessels. The structures in contact with the under surface will be seen when the muscle is cut through. The upper border overlies the gluteus medius. The lower edge, which is longer and thicker than the upper, in its inner part bounds posteriorly

the perineal space, and in the rest of its extent lies obliquely across the back of the thigh. The hamstring muscles and the sciatic vessels and nerves issue beneath it.

Action. With the femur hanging the muscle extends the hip-joint by pulling back that bone. The upper part abducts, but the part inserted into the femur adducts the limb and rotates it outwards. use on femur,

When the limb is fixed, and the body is raised from a sitting into a standing posture, the gluteus acts as an extensor of the articulation by moving back the pelvis ; and in standing on one on pelvis,

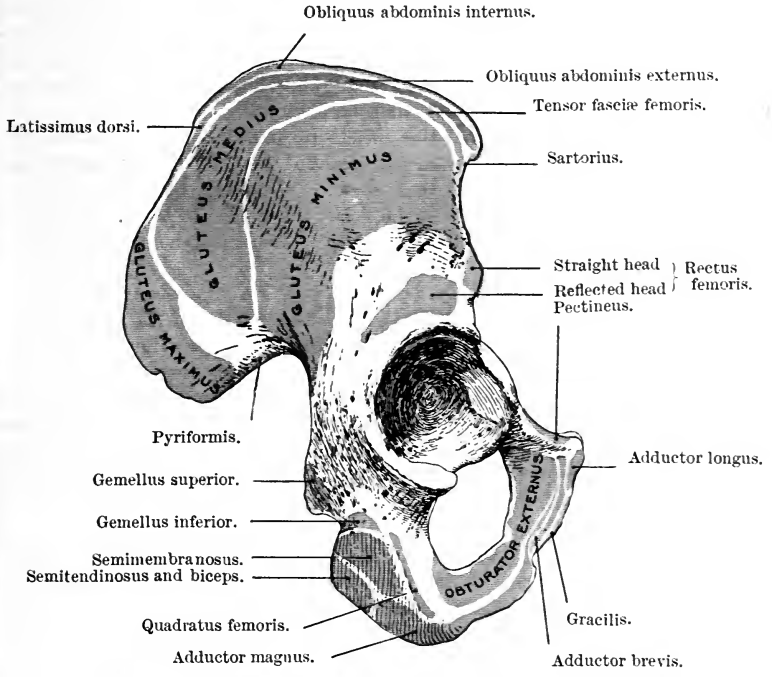


FIG. 47.—OS INNOMINATUM : OUTER AND POSTERIOR VIEW.

leg, the muscle can draw the sacrum towards the femur, so as to turn the face to the opposite side.

By tightening the ilio-tibial band (which is attached, below, to the front of the outer tuberosity of the tibia, to the outer side of the patella and to the fascia over the muscles of the front of the leg), the gluteus maximus also supports and steadies the knee-joint in the extended position. In this action it is assisted by the tensor fasciæ femoris, which corrects the tendency of the gluteus to draw the ilio-tibial band backwards. and on knee.

Dissection (fig. 48). The gluteus maximus is to be cut across a little external to the middle ; and the depth of the muscle will Divide the gluteus maximus,

be ascertained by the fascia and some vessels beneath it. When this intermuscular layer is arrived at, the outer piece of the gluteus may be at once thrown towards its insertion ; but the inner piece is to be carefully raised, and the branches of the inferior gluteal nerve, and of the gluteal and sciatic arteries entering its deep surface, are to be cleaned.

clean parts beneath,

The loose fat is then to be taken away from the hollow between the pelvis and the trochanter, without injuring the vessels and nerves ; and the several muscles are to be cleaned, the fibres of each being made tense at the time of its dissection by rotating the femur. The vessels, nerves, and muscles, which are to be defined may be ascertained by referring to the enumeration below of the parts beneath the gluteus. In removing the areolar tissue from the ischial tuberosity and from the great trochanter, a bursa over each prominence of bone may be observed.

remove origin,

and dissect out sacral nerves.

Lastly, the fibres of the muscle are to be detached at their origin ; and the inner piece may be removed entirely by cutting through the vessels and nerves that enter it. In doing this the sacral nerves are to be dissected out of the fleshy fibres, and to be followed to the surface of the great sacro-sciatic ligament, where they will be afterwards seen.

Parts covered by gluteus at its origin

and insertion ;

Parts beneath the gluteus (fig. 48). At its origin the gluteus maximus rests on the pelvis, and conceals part of the ilium, sacrum and coccyx, also the ischial tuberosity with the origin of the hamstring muscles (L) and the great sacro-sciatic ligament (K). At its insertion it covers the upper end of the femur, with the great trochanter, and the origin of the vastus externus (I). Between the muscle and the trochanter is a large, loose synovial membrane ; between it and the vastus externus is another synovial sac ; and occasionally there is a third over the ischial tuberosity.

and by the intervening piece of the muscle.

In the hollow between the pelvis and the femur the muscle conceals, from above downwards, the undermentioned parts (fig. 48) :—First, a portion of the gluteus medius (A) ; and below it the pyriformis (B), with the superficial branch of the gluteal vessels between the two. Coming from beneath the pyriformis are the inferior gluteal nerve supplying the gluteus maximus, and the large (^{6}) and small sciatic nerves, with the sciatic vessels, which descend to the thigh between the great trochanter and the ischial tuberosity ; and internal to the sciatic are the pudic vessels and nerve, and the nerve to the obturator internus muscle, which are directed inwards through the small sacro-sciatic foramen. Still lower down is the tendon of the obturator internus muscle (D) with a fleshy fasciculus—the gemellus (C and E)—above and below it. Next comes the quadratus femoris muscle (G) with the upper part of the adductor magnus (H) ; at the upper border of the quadratus, and deep to it, is the tendon of the obturator externus ; and at the lower border, between it and the adductor, issues one of the terminal branches of the internal circumflex artery with its veins.

Dissection. Tracing back the offsets of the sacral nerves which perforate the gluteus, and removing a fibrous stratum which covers them, the looped arrangement of the first three nerves on the great

Trace sacral nerves.

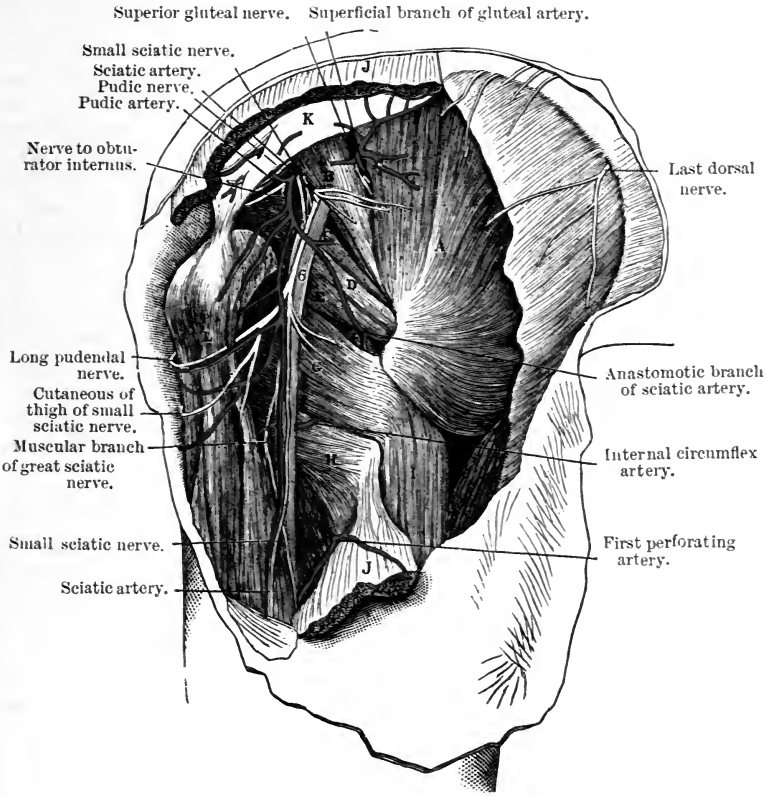


FIG. 48.—SECOND VIEW OF THE DISSECTION OF THE BUTTOCK (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Gluteus medius.
B. Pyriformis.
C. Upper gemellus.
D. Obturator internus.
E. Lower gemellus.
F. Obturator externus.
G. Quadratus femoris.
H. Adductor magnus.
I. Vastus externus.
J. Gluteus maximus, cut.
K. Great sacro-sciatic ligament.
L. Hamstring muscles.

Nerves:

6. Great sciatic.

Above the small sciatic are branches of the lower gluteal nerve, cut.

sacro-sciatic ligament will appear. Finally, the nerves may be followed inwards beneath the multifidus spinæ to the posterior sacral foramina.

The sacral nerves are united beneath gluteus:

SACRAL NERVES. The external pieces of the posterior primary branches of the first three sacral nerves, after passing outwards beneath the multifidus spinæ, are joined to one another by loops on the surface of the great sacro-sciatic ligament.

cutaneous offsets.

Two or three cutaneous offsets are derived from this intercommunication, and pierce the fibres of the gluteus maximus to be distributed on its surface as already seen.

Gluteus medius

The GLUTEUS MEDIUS (fig. 48, A) is triangular in form, with its base at the iliac crest, and apex at the femur. It *arises* from the

arises from hip-bone,

outer surface of the ilium between the crest and the superior curved line above, and the middle curved line below (fig. 47); and many superficial fibres come from the strong fascia covering the front of the muscle. The fibres converge to a tendon, which is *inserted*

and inserted into trochanter:

into an impression running downwards and forwards across the outer surface of the great trochanter, extending from the tip behind to the root in front (fig. 61, p. 158).

relations;

The superficial surface is concealed in part by the gluteus maximus; and the deep is in contact with the gluteus minimus, and the gluteal vessels and nerve. The anterior border lies over the gluteus minimus, and is in contact with the tensor fasciæ femoris. The posterior is contiguous to the pyriformis, only the superficial part of the gluteal vessels intervening. A small bursa is interposed between the tendon of insertion and the trochanter.

use with limb hanging,

Action. The whole muscle abducts the hanging femur; and the anterior fibres rotate the limb inwards.

both limbs fixed, in standing on one leg,

Both limbs resting on the ground, the muscles assist in fixing the pelvis. In standing on one leg this gluteus will aid in balancing the pelvis on the top of the femur, and will draw the body over to the same side.

and walking.

In walking the fore part of the muscle acts in rotating the pelvis over the fixed limb.

Detach gluteus medius to see gluteal vessels

Dissection. The gluteus medius is now to be detached from the pelvis, and partly separated from the gluteus minimus beneath, so that the gluteal vessels and the superior gluteal nerve may come into view. The two chief branches of the artery—one being near the upper border of the gluteus minimus, and the other lower down —are to be traced beneath the fleshy fibres as the reflection of the

and nerve.

gluteus is proceeded with; and the main piece of the nerve is to be followed forwards to the tensor fascia femoris muscle. The branches of the artery and nerve to the gluteus medius will be cut in removing that muscle.

Gluteal artery is

The GLUTEAL ARTERY is the largest branch of the internal iliac, and issues from the pelvis above the pyriformis muscle, where it

divided into two:

at once divides into superficial and deep parts:—

superficial

The *superficial part* (fig. 48) enters the under surface of the gluteus maximus and ramifies in that muscle. Some terminal twigs pass inwards over the sacrum, and others are given to the integuments.

and deep parts;

The *deep part* (fig. 50, *a*, p. 122) is the continuation of the artery, and subdivides into two pieces which run between the two smaller

glutei. One (superior; *b*) courses along the upper border of the gluteus minimus (supplying mostly the medius) to the front of the iliac crest, where it anastomoses with the ascending branch of the external circumflex artery. The other portion (inferior; *c*) is directed forwards over the middle of the smallest gluteal muscle, with the nerve, towards the anterior lower iliac spine, where it enters the tensor fasciæ femoris, and communicates with the external circumflex artery (p. 159): many offsets are furnished to the gluteus minimus, and some pierce that muscle to supply the hip-joint.

the latter has an upper and a lower branch.

Vein. The companion vein with the artery enters the pelvis, and ends in the internal iliac vein.

Gluteal vein.

The SUPERIOR GLUTEAL NERVE (fig. 50, [1]) is the highest branch of the sacral plexus, and arises from the lumbo-sacral cord and the first sacral nerve (fig. 49, p. 120). It accompanies the gluteal artery, and divides into two for the supply of the gluteus medius and minimus; its lower branch terminates anteriorly in the tensor fasciæ femoris (B).

Superior gluteal nerve is muscular.

The GLUTEUS MINIMUS (fig. 50, C) is triangular in shape, and *arises* from the dorsum of the ilium between the middle and inferior curved lines, extending backwards as far as the middle of the anterior margin of the great sciatic notch (fig. 47). Its tendon is *inserted* into an impression along the fore part of the great trochanter of the femur (fig. 60, p. 157), where it is united inferiorly with the gluteus medius: some fibres are attached to the capsule of the hip-joint.

Gluteus minimus: attachments.

One surface is in contact with the gluteus medius, and the gluteal vessels and nerve; the other with the hip-bone, the hip-joint, and the outer head of the rectus femoris muscle. The anterior border lies by the side of the gluteus medius; and the posterior is covered by the pyriformis muscle. A bursa is placed between the tendon and the bone.

relations;

Action. This muscle agrees in its action with the gluteus medius; but as it reaches farther backwards, the hinder fibres may also have some influence in rotating the hanging femur outwards.

use like medius.

Dissection. Cut through the smallest gluteal muscle near the ilium, and define the tendinous portion of the rectus femoris underneath it, close above the hip-joint. While detaching the gluteus from the parts underneath, the student will notice the connection between its tendon and the capsule of the joint.

Divide smallest gluteus;

The deep vessels to the articulation may be observed and followed as the muscle is removed.

trace deep vessels.

The *posterior* or *reflected head of the rectus femoris* is a tendon as wide as the finger, and about two inches long, which is fixed into the impression above the margin of the acetabulum. In front it joins the *straight* head of the muscle, which is attached to the anterior inferior iliac spine; and its lower border is connected with the capsule of the hip-joint.

Posterior head of the rectus.

The PYRIFORMIS (fig. 48, B and fig. 50, F) *arises* in the pelvis

Origin of pyriformis;

from the front of the sacrum between and outside the second, third, and fourth foramina, and leaves that cavity through the great sacro-sciatic foramen to end in a rounded tendon, which is *inserted* into the upper edge of the great trochanter of the femur (fig. 60, p. 157).

insertion;

relations in foramen,

The muscle occupies the greater part of the sacro-sciatic foramen, and divides the vessels and nerves passing through that aperture into two groups :—*Above it* are the gluteal vessels and the superior gluteal nerve ; and *below it* the sciatic and pudic vessels and nerves,

in buttock;

and some other branches of the sacral plexus. Its upper border is contiguous to the gluteus medius ; and its lower, to the superior gemellus. Like the other rotator muscles in this situation, it is covered by the gluteus maximus, and by the gluteus medius at the insertion ; it rests on the gluteus minimus, which separates it from the hip-joint. Its tendon is united by fibrous tissue to that of the obturator and gemelli.

use with femur hanging, and raised;

Action. The pyriformis rotates out the femur when that bone is in a line with the trunk ; but if the hip-joint is bent it abducts the limb.

both limbs on ground,

Both limbs being fixed, the muscles balance the pelvis, and help to make the trunk erect after stooping to the ground. In standing on one leg, besides assisting to support the trunk, the pyriformis turns the face to the opposite side.

only one.

Dissect out the chief vessels and nerves,

Dissection. The pyriformis may now be cut across and raised towards the sacrum, to allow the dissector to follow upwards the sciatic and pudic vessels, and to trace the accompanying nerves to their origin from the sacral plexus.

and muscular branches.

A small nerve to the obturator internus (fig. 50, [5]) and gemellus superior is to be sought for in the fat at the lower border of the plexus passing over the spine of the ischium on the outer side of the internal pudic artery. A branch to the quadratus and inferior gemellus ([6]) may be found by raising the trunk of the great sciatic nerve ; but this will be followed to its termination after the muscles it supplies have been seen.

The vessels come from the iliac.

SCIATIC AND PUDIC VESSELS. The arteries on the back of the pelvis, below the pyriformis muscle, are branches of the internal iliac, which will be described in dissection of the pelvis.

Sciatic artery:

The SCIATIC ARTERY (fig. 48) supplies the buttock below the gluteal. After escaping from the pelvis below the pyriformis, it descends with the small sciatic nerve over the gemelli and

course and ending;

obturator internus muscles, as far as the lower border of the gluteus maximus ; in its course the artery gives off many branches with the superficial offsets of its companion nerve ; and, much reduced in size, it is continued with that nerve along the back of the thigh.

branches;—coccygeal;

In this course it furnishes the following branches :—

a. The *coccygeal branch* arises close to the pelvis, perforates the great sacro-sciatic ligament and the gluteus maximus, and ramifies in this muscle, and on the back of the sacrum and coccyx.

branch to sciatic nerve;

b. The *branch to the great sciatic nerve* (comes nervi ischiadici) is very slender, and entering the nerve near the pelvis, ramifies in it along the thigh.

c. Muscular branches enter the gluteus maximus, the upper gemellus, and obturator internus; and by means of a branch to the quadratus, which passes with the nerve of the same name beneath the gemelli and obturator internus, it gives offsets to the hip-joint and the inferior gemellus. muscular;

d. Anastomotic branch (fig. 48). Varying in size, this artery is directed outwards along the lower border of the pyriformis to the root of the great trochanter, where it anastomoses with the internal circumflex and first perforating arteries. anastomotic.

The INTERNAL PUDIC ARTERY (fig. 48) belongs to the perineum and the genital organs: it is smaller than the sciatic, internal to which it lies. Only the small part of the vessel which winds over the ischial spine is seen on the back of the pelvis, for it enters the perineal space through the small sacro-sciatic foramen, and is there distributed. Pudic artery crosses the ischial spine:

It supplies a small branch over the back of the sacrum, which anastomoses with the gluteal and sciatic arteries; and a twig from it accompanies the nerve to the obturator internus muscle. offsets.

The *veins* with the sciatic and pudic arteries receive tributaries corresponding with the branches of those arteries at the back of the pelvis, and open into the internal iliac vein. Veins.

NERVES. The nerves appearing at the back of the pelvis, below the pyriformis, are derived from the plexus (*sacral plexus*) formed within the pelvis by anterior branches from the lower two lumbar and the upper four sacral nerves; the largest are furnished to parts beyond the gluteal region, but some are distributed to the muscles at the back of the pelvis. Nerves come from sacral plexus.

The INFERIOR GLUTEAL NERVE is larger than the superior, and arises from the upper part of the sacral plexus (fig. 49, i g). The short trunk is directed backwards below the pyriformis, and divides into numerous branches which radiate upwards and downwards, and enter the gluteus maximus midway between its origin and insertion. Inferior gluteal to gluteus maximus.

The SMALL SCIATIC (fig. 48) is a cutaneous nerve of the back of the thigh. It springs from the second and third sacral nerves (fig. 49, s s), and takes the course of the sciatic artery as far as the lower border of the great gluteus, where it gives many cutaneous branches. Much diminished in size at that spot, the nerve is continued along the back of the thigh beneath the fascia, and ends below the knee in the integuments of the back of the leg. The branches distributed to, or near the buttock, are the following:— Small sciatic is a cutaneous nerve; ends in the leg;

The *ascending* or *gluteal cutaneous branches* (fig. 46) turn upwards round the border of the gluteus maximus, and are distributed to the skin over the lower third of the muscle. ascending

The *descending cutaneous branches* (fig. 46,[2]) supply the integuments of the upper third of the thigh at the inner and posterior aspects. One of these branches (fig. 48), which is larger than the others, is distributed to the genital organs, and is named *inferior pudendal;* as it courses to the perineum, it turns below the and descending cutaneous branches; inferior pudendal nerve.

ischial tuberosity, and perforates the fascia lata at the inner side of the thigh to end in the scrotum.

Great sciatic nerve: outline of;

The GREAT SCIATIC (fig. 48,[6]) is the largest nerve in the body. It is the source of all the muscular, and most of the cutaneous

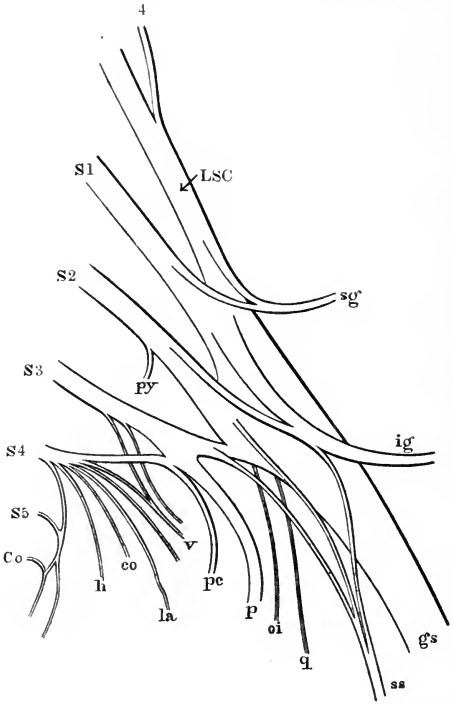


FIG. 49.—DIAGRAM OF THE SACRAL PLEXUS FROM BEHIND.

L S C. Lumbo-sacral cord formed by the fifth lumbar nerve and a small branch from the fourth.
S 1 to S 5. First to fifth sacral nerves.
g s. Great sciatic nerve.
s s. Small sciatic.
s g. Superior gluteal.
i g. Inferior gluteal.
p. Pudic.
p c. Perforating cutaneous.
py. Branch to pyriformis.
o i. Nerve to obturator internus.
q. Nerve to quadratus femoris.

The remaining references are explained in the dissection of the plexus in the pelvis.

branches to the limb beyond the knee, as well as of the muscular branches at the back of the thigh.

course in the buttock;

At its origin it appears to be a prolongation of the sacral plexus (fig. 49, *g s*). It is directed through the buttock to the back of the thigh, and rests, in succession, on the superior gemellus, the tendon of the obturator internus, the inferior gemellus and the quadratus femoris muscles below the pyriformis. Commonly it does not supply any branch to the buttock, but it may give origin

no branch in this region.

to one or two filaments to the hip-joint. Frequently the nerve is divided into two large trunks at its origin, and one of them (the external popliteal) pierces the fibres of the pyriformis muscle.

The PUDIC NERVE (fig. 48) winds over the small sacro-sciatic ligament on the inner side of its companion artery, and is distributed with this vessel to the perineum and the genital organs. No branch is supplied to the buttock. Pudic nerve.

Small MUSCULAR BRANCHES of the sacral plexus are furnished to the external rotators except the obturator externus. Muscular branches :

The *branch to the pyriformis*, from the second sacral nerve, is seen in the dissection of the sacral plexus in the pelvis. to pyriformis ;

The *nerve to the obturator internus* (fig. 50,[5]) arises from the upper part of the plexus, and is directed to its muscle through the small sacro-sciatic foramen external to the pudic vessels : it gives off a small twig to the superior gemellus ([7]). to obturator internus and superior gemellus ;

The *nerve to the quadratus femoris* (fig. 50,[6]) is a slender branch, which passes with a companion artery beneath the gemelli and the obturator to the anterior surface of its muscle. This branch will be seen more fully in a subsequent dissection, when offsets from it to the inferior gemellus and the hip-joint may be traced. to quadratus and inferior gemellus.

Dissection. To see the remaining external rotator muscles, hook aside the great sciatic nerve, and take away the branches of the sciatic artery if it is necessary. In cleaning these muscles the limb should be rotated inwards. The gemelli are to be separated from the tendon of the obturator internus. Clean rotator muscles.

The SUPERIOR GEMELLUS (fig. 48, C) is the higher of the two muscular slips along the sides of the tendon of the obturator muscle. Internally it *arises* from the outer and lower part of the ischial spine (fig. 47, p. 113), and externally it is *inserted* with the obturator into the great trochanter. Occasionally the muscle is absent. Superior gemellus.

The INFERIOR GEMELLUS (fig. 48, E) is larger than its fellow. Its *origin* is connected with the upper part of the ischial tuberosity, along the lower edge of the groove for the obturator internus muscle (fig. 47) ; and its *insertion* is in common with the obturator tendon. This muscle is placed between the obturator internus and quadratus, but near the femur the tendon of the obturator externus comes into contact with its upper border. Inferior gemellus : both inserted with obturator ;

Action. These small fleshy slips are but accessory pieces of origin to the internal obturator, with which they combine in use. use to help obturator.

The OBTURATOR INTERNUS (fig. 48, D) arises from the hip-bone inside the pelvis, and passes to the exterior through the small sacro-sciatic foramen. The tendon of the muscle is directed outwards over the hip-joint, and is *inserted* with the gemelli, in front of the pyriformis, into the inner side of the great trochanter, at the upper and fore part (fig. 60, p. 157). Obturator internus outside pelvis : insertion ;

Outside the pelvis the obturator is mostly tendinous, and is embraced by the gemelli muscles, which near the pelvis meet beneath the tendon ; but near the trochanter they cover it. Crossing the muscle are the large and small sciatic nerves and the relations ;

tendon is divided on the edge of the pelvis;

sciatic vessels; and covering the whole is the gluteus maximus. On cutting through the tendon and raising the inner end, it will

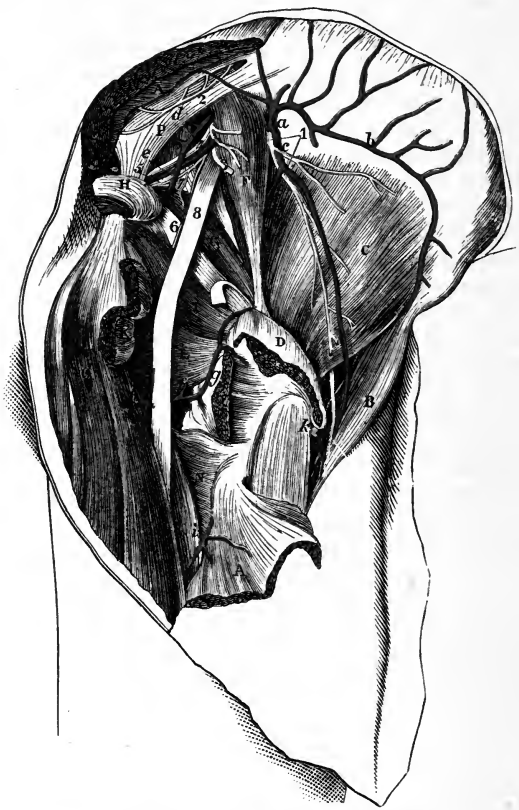


FIG. 50.—THIRD VIEW OF THE DISSECTION OF THE BUTTOCK (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Gluteus maximus, cut.
B. Tensor fasciæ latæ.
C. Gluteus minimus.
D. Gluteus medius, cut.
F. Pyriformis.
G. Gemellus superior
H. Obturator internus, cut.
I. Gemellus inferior.
K. Quadratus femoris, cut.
L. Obturator externus.
N. Adductor magnus.
O. Hamstrings.
P. Great sacro-sciatic ligament.

Arteries:

a. Gluteal.
b. Its upper, and *c*, its lower piece.
d. Sciatic.
e. Pudic.
f. Internal circumflex.
g. Its ascending, and *h*, its transverse offset.
i. First perforating.
k. External circumflex.

Nerves:

1. Superior gluteal.
2. Sacral.
3. Small sciatic, cut.
4. Pudic.
5. Nerve to obturator internus.
6. Nerve to quadratus and inferior gemellus.
7. Branch to upper gemellus.
8. Great sciatic.

be found divided into four or five pieces as it turns over the ischium (fig. 50, H); at this spot the bone is covered with cartilage, which forms ridges corresponding to the intervals between the tendinous slips, and the surfaces are lubricated by a synovial sac. There is sometimes another bursa between the tendon and the hip-joint.

Action. The action of this muscle is in all respects the same as that of the pyriformis (p. 118), although, as it acts at a greater mechanical advantage, it is a much more powerful external rotator. use like pyriformis.

The QUADRATUS FEMORIS (fig. 48, G) is situate between the inferior gemellus and the adductor magnus. Internally it *arises* from the outer border of the ischial tuberosity for two inches, by the side of the semimembranosus and adductor magnus (fig. 47, p. 113); externally it is *inserted* into an eminence on the posterior intertrochanteric ridge of the femur (tubercle of the quadratus), and along a line on the upper end of that bone for about one inch and a half, above the attachment of the great adductor (fig. 61, p. 158). Quadratus femoris: origin; insertion;

By one surface it is in contact with the sciatic vessels and nerves, and the gluteus maximus. By the other it rests on the obturator externus, the internal circumflex vessels, and its small nerve and vessels. Between its lower border and the adductor magnus the transverse branch of the internal circumflex artery issues. Between it and the small trochanter is a bursa, which is also common to the upper part of the adductor magnus. parts over and beneath it, and at lower border;

Action. The quadratus differs from the foregoing muscles of the same group in being able to rotate the femur outwards when the hip-joint is bent, as well as in the extended position; and it will assist slightly in adducting the limb. use.

Dissection (fig. 50). The quadratus and the gemelli muscles may now be cut across, in order that their small nerve and artery, the ending of the internal circumflex artery, and the obturator externus may be dissected out. Divide quadratus and gemelli.

The INTERNAL CIRCUMFLEX ARTERY (fig. 50) from the profunda femoris artery (p. 166) divides finally into two pieces. One (*ascending*) runs beneath the quadratus (in this position of the body) to the pit of the trochanter, where it anastomoses with the gluteal and sciatic arteries, and supplies the bone. The other (*transverse*) passes between the quadratus and adductor magnus to the hamstring muscles, and communicates with the perforating arteries. Internal circumflex artery ends in two branches.

The OBTURATOR EXTERNUS (fig. 50, L) will be dissected at its origin in the front of the thigh. The part of the muscle now laid bare winds below the hip-joint, and ascends to be *inserted* into the pit at the root of the trochanter. Obturator externus is inserted into pit of trochanter;

On the back of the pelvis the obturator externus is covered by the quadratus, except near the femur where it is exposed between that muscle and the inferior gemellus. Its deep surface is in contact with the capsule of the hip-joint and the neck of the femur. relations;

Action. Like the quadratus femoris, it rotates the femur outwards in all positions of the limb: it is also to a slight extent an adductor and flexor of the hip-joint. use.

Sacro-sciatic ligaments: The SACRO-SCIATIC LIGAMENTS pass from the sacrum and coccyx to the ischium: they are two in number, and are named great and small.

large, The *great* or *posterior ligament* (fig. 50, P) is attached above to the posterior inferior iliac spine, and to the side of the sacrum and coccyx; and below, to the inner margin of the ischial tuberosity sending forwards a prolongation along the ramus of the bone: some of the superficial fibres are continued over the tuberosity into the long head of the biceps.

It is wide next the sacrum, and becomes narrower below; but it is somewhat expanded again at the tuberosity. On the cutaneous surface are the branches of the sacral nerves; and the gluteus maximus conceals and takes origin from it. Branches of the sciatic artery and a cutaneous nerve from the sacral plexus perforate it.

and small; The *small* or *anterior ligament* passes from the sacrum and coccyx to the ischial spine, but this band will be more fully seen in the dissection of the pelvis.

form two foramina; These ligaments convert the deep sacro-sciatic notch of the dried pelvis into two foramina. Between their insertion into the spine and tuberosity of the hip-bone is the small sacro-sciatic foramen,

small, with contents; which contains the internal obturator muscle with its nerve and vessels, and the pudic vessels and nerve. And above the smaller

large, and parts passing through it. ligament is the large sacro-sciatic foramen, which gives passage to the pyriformis muscle, with the gluteal vessels and the superior gluteal nerve above it, and the sciatic and pudic vessels and nerves, the inferior gluteal nerve, and the nerves to the obturator internus and quadratus femoris below it.

SECTION II.

THE POPLITEAL SPACE AND THE BACK OF THE THIGH.

Directions. *Directions.* The ham or popliteal space should be taken after the buttock, in order that it may be seen in a less disturbed state than if it were dissected after the examination of the muscles at the back of the thigh. When this space has been learnt, the student will return to the dissection of the thigh.

Position. *Position.* The limb should be raised on blocks into the horizontal position.

Take the skin from over the ham. **Dissection** (fig. 51, p. 126). To remove the skin from the popliteal region, let a longitudinal incision be made behind the knee from a distance of six inches above to four inches below the joint. At each extremity of this cut make a transverse incision, and raise the skin in two flaps, the one being turned outwards and the other inwards.

Seek the cutaneous nerves. In the fat are some small cutaneous nerves, viz., one or two twigs in the middle line of the limb from the small sciatic nerve beneath

the fascia ; and some offsets of the internal cutaneous nerve towards the inner side. After the subcutaneous fat is removed, the special fascia of the limb will be brought into view.

Fascia lata. Where this fascia covers the popliteal space it is strengthened by transverse fibres, particularly on the outer side ; and it is connected laterally with the tendons bounding that interval. The short saphenous vein perforates it opposite the knee, or a little lower down. Fascia of the limb over the ham.

Dissection (fig. 51, p. 126 ; also fig. 53, p. 131). The fascia over the ham is now to be removed without injuring the small sciatic nerve and accompanying artery, and the short saphenous vein, which are close beneath it. A large quantity of fat may be next taken out of the space, but without injury to the several small vessels and nerves in it. Remove fascia, and take the fat from the ham.

In cleaning the space the student will come upon the large internal popliteal nerve in the middle, and the external popliteal on the outer side. Both nerves give branches ; and the numerous offsets of the inner will be recognised more certainly by tracing them from above downwards along the trunk of the nerve, than by proceeding in the opposite direction : in fat bodies the two small nerves from the inner popliteal trunk to the knee-joint are difficult to find. Under cover of the outer boundary, and deep in the space, is an articular nerve from the external popliteal. Seek the nerves in the space.

In the bottom of the space are the popliteal vessels, the vein being more superficial than the artery. The student is to seek an articular branch (superior) on each side, close above the condyle of the femur, and to clean numerous other branches of the vessels to the muscles around, especially to those of the calf. On the upper part of the artery, the branch of nerve from the obturator to the knee-joint is to be found ; and on the sides of the artery are three or four lymphatic glands in the fat. Clean the vessels ; find obturator nerve, and glands.

The POPLITEAL SPACE, or ham (fig. 51) is the hollow behind the knee : it allows of the free flexion of the joint, and contains the large vessels of the limb. When dissected, this interval has the form of a lozenge, and extends upwards along one-third of the femur, and downwards along one-sixth of the tibia ; but in the natural condition the muscles on the sides are approximated by the fascia of the limb, and the space is limited to the region immediately above the joint. The ham : situation and extent ;

This hollow is situate between the muscles on the back of the limb ; and the lateral boundaries are therefore formed by the muscles of the thigh (hamstrings), and leg. Thus, on the outer side, is the biceps muscle (6) as far as the joint, and the plantaris and the external head of the gastrocnemius (8) beyond that spot. On the inner side, as low as the articulation, are the semimembranosus (4) and semitendinosus (5) muscles with the gracilis and sartorius between them and the femur ; and below the joint is the inner head of the gastrocnemius (7). The upper point of the ham is formed by the apposition of the inner and outer hamstrings ; and at the lower point the heads of the gastrocnemius touch each other. boundaries, outer and inner : limit above and below ;

superficial and deep boundaries;

Stretched over the cavity are the fascia lata and the integuments. In the deep boundary, or the floor, are the following structures:—the surface on the back of the femur included between the supracondylar (popliteal surface), the posterior ligament of the knee-joint, and part of the popliteus muscle with the upper end of the tibia (fig. 52, p. 128).

greatest width and depth;

The popliteal space is widest and deepest immediately above the femoral condyles. (Above and below it communicates, beneath the muscles, with the back of the thigh and leg.)

contents.

In the hollow are contained the popliteal vessels with their branches, and the ending of the external saphenous vein; the popliteal trunks of the great sciatic nerve, and some of their branches together with lymphatic glands and a large quantity of fat. The small sciatic nerve and its vessels are placed superficially in the ham; and a branch of the obturator nerve lies on the artery in the bottom of the space.

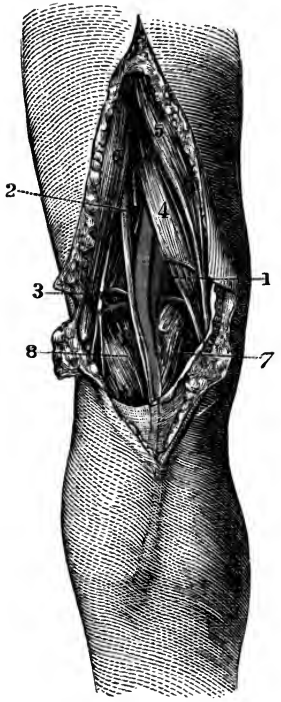


Fig. 51.—View of the Popliteal Space (Quain's Arteries).

1. Popliteal vessels.
2. Internal popliteal nerve.
3. External popliteal nerve.
4. Semimembranosus muscle.
5. Semitendinosus muscle.
6. Biceps muscle.
7, 8. Inner and outer heads of the gastrocnemius muscle. The superficial vein on the gastrocnemius is the short saphenous, which enters the popliteal.

Popltieal artery:

The popliteal artery (fig. 51[1] and fig. 52) is the continuation of the superficial femoral, and reaches from the opening in the adductor magnus to the lower border of the popliteus muscle, where it terminates by bifurcating into the anterior and posterior tibial arteries. A portion of the artery lies in the popliteal space, and is not covered by muscle; but both above and below, it is concealed by the muscles bounding the hollow. The description of the artery may be conveniently divided into two parts—one reaching to the lower limit of the ham, and the other being beneath the gastrocnemius.

extent;

only a small part in space.

The part in the ham:

As far as the ham the vessel is inclined obliquely from the inner side of the limb to the interval between the condyles of the femur, and is then directed along the middle of the space over the knee-joint. The artery is overlain by the belly of the semimembranosus muscle to within an inch of the internal condyle; but thence onwards it is situate between

course and relations;

the heads of the gastrocnemius, and is covered only by the fascia lata and the integuments. Beneath it is the femur, with the posterior ligament of the knee-joint.

position of the vein,

In contact with the vessel, and somewhat on the outer side at first, lies the popliteal vein, so that on looking into the space, the arterial trunk is almost covered ; but in the interval between the heads of the gastrocnemius, the vein and its branches altogether conceal the artery. In the lower part of the ham the short saphenous vein (fig. 53, *i*, p. 131) and the muscular branches of the artery are also superficial to the popliteal trunk.

and of the nerves.

More superficial than the large vessels, and slightly external to them in position, is placed the internal popliteal nerve, which, with its branches, lies over the artery, like the vein, between the heads of the gastrocnemius. In the bottom of the hollow the small obturator nerve runs on the artery to the joint.

Cut inner head of the gastrocnemius.

Dissection. To see the deep part of the artery, the inner head of the gastrocnemius should be cut through and raised. On removing the areolar tissue the vessels and nerves will appear. The lower articular branches of the vessels and nerve are now brought into view ;—the inner artery is below the head of the tibia, and the outer, higher up, between the femur and the fibula, each with a vein ; and a companion nerve.

Artery beyond ham :

Beyond the ham. While the artery is *beneath the gastrocnemius* sinks deeply into the limb ; here it is crossed by a small muscle—the plantaris (c), and the ending is concealed by the soleus (b). It rests on the popliteus muscle.

position of vein and nerve.

Both the companion vein and the internal popliteal nerve change their position to the artery, and gradually cross over it, so as to lie on its inner side at the lower border of the popliteus.

High division.

Sometimes the artery bifurcates as high as the back of the knee-joint ; and then the anterior tibial artery may lie beneath the popliteus muscle.

Branches of artery.

Branches (figs. 52 and 53) are furnished by the artery to the surrounding muscles, to the integuments, and to the articulation ;—those that belong to the joint are five in number, and are called articular, viz., two superior, inner and outer ; two inferior, also inner and outer ; and a central or azygos branch.

Muscular branches,

1. The *muscular branches* are upper and lower. The upper set, three or four in number, arise above the knee, and end in the semimembranosus and biceps muscles, communicating with the perforating and muscular branches of the profunda. The lower set (sural) are furnished to the muscles of the calf, viz., gastrocnemius, soleus, and plantaris.

and cutaneous.

2. The *cutaneous* or *superficial sural branches* descend to the skin of the calf of the leg : they are usually three in number, one in the middle line, and one over each head of the gastrocnemius.

Articular branches are five : Two superior :

3. The *superior articular arteries* arise from the popliteal trunk, one from the inner and one from the outer side, above the condyles of the femur ; they are directed almost transversely beneath the hamstring muscles, and turn round the bone to the front of the joint.

external: The *external branch* perforates the intermuscular septum, and divides in the substance of the crureus. Some of the branches end in that muscle, and anastomose with the external circumflex (of the profunda); others descend to the joint and anastomose with the lower external articular artery; and one offset forms an arch across the front with the anastomotic artery.

internal. The *internal artery*, oftentimes very small, winds beneath the

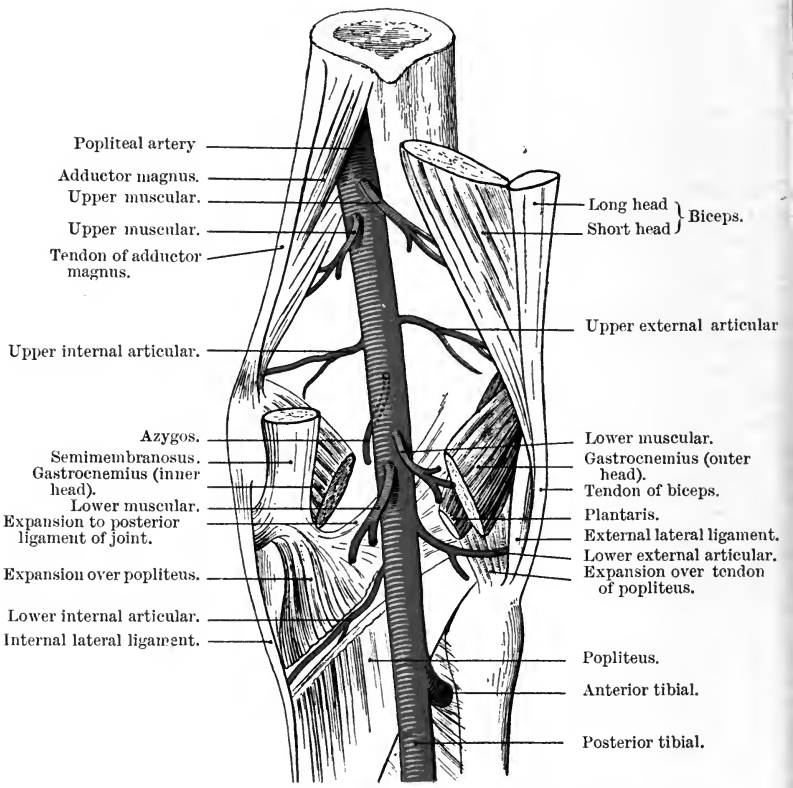


FIG. 52.—POPLITEAL ARTERY AND BRANCHES.

tendon of the adductor magnus, and terminates in the vastus internus; it supplies this and the knee-joint, and communicates with the deep part of the anastomotic artery.

Two inferior: 4. The *inferior articular arteries* lie beneath the gastrocnemius, but are not on the same level on opposite sides of the limb; for the inner one descends below the internal tuberosity of the tibia, while the outer one is placed above the head of the fibula. Each lies beneath the lateral ligament of its own side.

external; The *external branch* supplies the outer side of the knee-joint,

anastomosing with the other vessels on the articulation, and with the recurrent branch of the anterior tibial artery; it sends an offset beneath the ligament of the patella to join a twig from one of the internal branches.

The *internal artery* ramifies over the front of the internal tuberosity of the tibia, and anastomoses with the upper internal and lower external articular branches, and with the superficial branch of the anastomotic artery. internal.

5. The *azygos branch* enters the joint through the posterior ligament, and is distributed to the ligamentous structures, the fat, and the synovial membrane of the interior. And one central artery.

The POPLITEAL VEIN (fig. 53, *h*) originates in the union of the anterior and posterior tibial venæ comites, and has the same extent and relations as the artery it accompanies. At the lower border of the popliteus muscle the vein is internal to the arterial trunk; between the heads of the gastrocnemius, it is superficial to that vessel; and thence to the opening in the adductor magnus it lies to the outer side of, and close to, the artery. It is joined by branches corresponding with those of the artery, as well as by the short saphenous vein. Popliteal vein. position to the artery; branches.

The POPLITEAL NERVES (fig. 51, p. 126) are the two large trunks derived from the division of the great sciatic in the thigh (p. 133), and are named internal and external. Each furnishes cutaneous and articular offsets, but only the inner one supplies branches to muscles. Popliteal nerves are two, inner and outer.

The INTERNAL POPLITEAL NERVE (2) is larger than the external, and occupies the middle of the ham: its relations are similar to those of the artery, that is to say, it is partly superficial, and partly covered by the gastrocnemius. The nerve is continued to the back of the leg, where it is called *posterior tibial;* the name popliteal is retained only to the lower border of the popliteus muscle. Its position to the vessels has been already noticed. The branches arising from it are the following:— Internal popliteal nerve: branches are

a. Two small *articular twigs* (fig. 53, 9) are furnished to the knee-joint with the vessels. One accompanies the lower internal articular artery to the front of the articulation, and is the larger; the other takes the same course as the azygos artery, and enters the back of the joint with it. two articular;

b. Muscular branches arise from the nerves between the heads of the gastrocnemius. One is furnished to each head of the gastrocnemius, and the outer of these usually supplies the plantaris. Another descends beneath the gastrocnemius, and enters the posterior surface of the soleus. And a fourth penetrates the popliteus at the anterior aspect, after turning round the lower border. four muscular;

c. The *tibial communicating branch* (fig. 71, 3, p. 188) is a cutaneous offset to the leg and foot. It lies beneath the fascia, and between the heads of the gastrocnemius, as far as the middle of the leg, where it becomes superficial, and unites with the peroneal communicating branch of the external popliteal, to form the short saphenous nerve (p. 187). and one cutaneous, the tibial communicating.

External popliteal nerve:

The EXTERNAL POPLITEAL NERVE (peroneal; fig. 51,[3]) lies along the outer boundary of the ham, and is at first concealed by the edge of the biceps muscle; becoming superficial, it is continued over the outer head of the gastrocnemius, following the hinder

course and ending;

border of the biceps tendon, until it is below the head of the fibula. There it enters the fibres of the peroneus longus, and divides beneath that muscle into two—musculo-cutaneous and anterior tibial. Its branches are articular and cutaneous:—

branches, articular,

a. The *articular nerve*, arising high in the space, runs with the upper external articular artery to the outer side of the knee, and sends a twig along the lower articular artery: both enter the joint.

peroneal communicating,

b. The *peroneal communicating branch* (fig. 71, [4], p. 188) soon pierces the fascia, and descends over the outer head of the gastrocnemius to join the tibial communicating from the internal popliteal in the short saphenous nerve.

and lateral cutaneous of leg.

c. One or two *lateral cutaneous branches* arise either in common with the preceding or separately, and supply the skin of the outer side of the leg, reaching nearly to the external malleolus.

Articular nerve of the obturator.

The ARTICULAR BRANCH OF THE OBTURATOR NERVE (fig. 53, [7]) perforates the adductor magnus (p. 164), and is conducted by the popliteal artery to the back of the knee. After supplying filaments to the vessels, the nerve enters the articulation through the posterior ligament.

Lymphatic glands around the artery.

The POPLITEAL LYMPHATIC GLANDS are situate round the large arterial trunk. Two or three are ranged on the sides; while one is superficial to, and another beneath the vessel: they are joined by the deep lymphatic vessels, and by the superficial set with the external saphenous vein.

THE BACK OF THE THIGH.

Dissect the back of the thigh.

Dissection (fig. 53). After the popliteal space, the student may proceed with the dissection of the back of the thigh. The piece of skin between the buttock and the ham should be divided in the middle line and reflected to the sides. In the fat on the

Seek out cutaneous nerves;

outer side of the limb fine offsets of the external cutaneous nerve of the thigh may be found; and along the middle some filaments from the small sciatic nerve pierce the fascia.

clean muscles and nerves.

Remove the deep fascia of the limb, taking care of the small sciatic nerve and its artery. Lastly, clean the hamstring muscles; trace the arteries from the front of the thigh, which perforate the muscle to get to the back; and clean the branches of the great sciatic nerve to the muscles.

Three muscles on back of thigh:

MUSCLES. The muscles behind the femur are flexors of the knee-joint. They reach from the pelvis to the bones of the leg, and are named hamstrings from the cord-like appearance on the sides of the ham. They are three in number, viz., biceps, semi-

situation.

tendinosus, and semimembranosus. The first of these lies on the outer, and the other two on the inner side of the popliteal space.

The BICEPS (fig. 53, D) has two heads of origin, long and short, which are attached to the pelvis and the femur. The long head *arises* from the lower and inner impression on the ischial tuberosity, in common with the semitendinosus muscle (fig. 47, p. 113). The short head arises from the femur below the gluteus maximus; from the outer lip of the linea aspera, from the upper three-fourths of the line leading to the outer condyle, as well as from the external intermuscular septum (fig. 61, p. 158). The fibres end below in a tendon, which is *inserted* into the head of the fibula embracing the external lateral ligament (fig. 68, p. 179); and a slight piece is prolonged to the head of the tibia.

The muscle is superficial except at its origin, where it is covered by the gluteus maximus; it rests on the upper end of the semimembranosus, on the

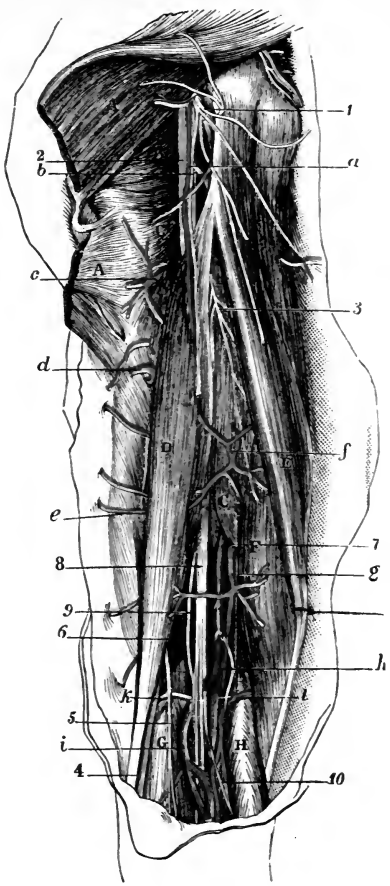


FIG. 53.—DISSECTION OF THE BACK OF THE THIGH (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Gluteus maximus, cut below, and partly raised.
B. Quadratus femoris.
C. Adductor magnus.
D. Biceps.
E. Semitendinosus.
F. Semimembranosus.
G. Outer, and H, inner head of the gastrocnemius.

Vessels:

a. Sciatic artery.
b. Ending of internal circumflex to hamstrings.
c. First, *d*, second, and *e*, third perforating arteries.
f. Muscular branch of profunda.
g. Popliteal artery.
h. Popliteal vein.
i. Short saphenous vein.
k. Upper external, and *l*, upper internal articular artery.

Nerves:

1. Small sciatic, cut.
2. Large sciatic.
3. Branch to hamstrings from large sciatic.
4. External popliteal.
5. Communicating peroneal.
7. Articular branch of obturator to knee.
8. Internal popliteal.
9. Articular branch to knee of the internal popliteal.
10. Tibial communicating.

great sciatic nerve and on the adductor magnus muscle. On the inner side are the semitendinosus and semimembranosus as far as the ham. Its tendon gives an offset to the deep fascia of the limb.

use on knee and hip-joints, on pelvis, and femur.

Action. It can bend the knee if the leg-bones are not fixed, and afterwards rotate out the tibia; and the long head will extend the bent hip-joint when the knee is straight.

The leg being supported on the ground, the long head will assist in balancing and erecting the pelvis; and the short head will draw down the femur so as to bend the knee in stooping.

Semitendinosus is attached to pelvis and tibia;

The SEMITENDINOSUS (fig. 53, E) is a slender muscle and receives its name from its appearance. It *arises* from the tuberosity of the ischium with the long head of the biceps, and by fleshy fibres from the tendon of that muscle. Inferiorly it is *inserted* into the inner surface of the tibia, close below the gracilis, and for a similar extent (fig. 68, p. 179).

parts in contact with it;

This muscle, like the biceps, is partly covered by the gluteus maximus. About its middle an oblique tendinous intersection may be observed. It rests on the semimembranosus, and on the internal lateral ligament of the knee-joint. The outer border is in contact with the biceps as far as the lower third of the thigh. As the tendon turns forwards to its insertion, an expansion is continued from it to the fascia of the leg; and it is attached, with the gracilis, on a level with the tubercle of the tibia, the two being separated from the internal lateral ligament by a bursa.

use on knee and hip-joints, on the pelvis.

Action. If the leg is movable, the muscle bends the knee and rotates inwards the tibia. Supposing the knee-joint straight but the hip-joint bent, the femur can be depressed, and the hip extended by this and the other hamstrings.

Should the limbs be fixed on the ground, the muscle will assist in balancing the pelvis, or in erecting the trunk from a stooping posture.

Semimembranosus reaches from pelvis to tibia;

The SEMIMEMBRANOSUS MUSCLE (fig. 53, F) is tendinous at both ends, and receives its name from the membraniform appearance of the upper tendon. The muscle *arises* from the upper and outer impression on the ischial tuberosity (fig. 47, p. 113); and it is *inserted* below into the inner and hinder part of the head of the tibia (fig. 73, p. 191), and from this position one fibrous expansion is sent outwards across the back of the knee-joint to the outer side of the external condyle of the femur, forming thereby the strongest part of the posterior ligament, and another proceeds downwards as a fascial investment over the back of the popliteus muscle (fig. 52, p. 128).

parts around it;

The muscle is thick and fleshy below, where it bounds the popliteal space. On it lies the semitendinosus, which is lodged, together with the long head of the biceps, in a hollow in the upper tendon; and beneath it is the adductor magnus. Along the outer border is first the great sciatic, and then the internal popliteal nerve. Between its tendon and the inner head of the gastrocnemius is a large bursa. The insertion of the muscle above described will be dissected with the knee-joint (p. 214).

Action. This hamstring is united with the preceding in its action, for it bends the knee and rotates in the tibia; and with the knee straight it will limit flexion of the hip, or extend this joint after the femur has been carried forwards. The extension across the back of the joint serves to keep the posterior ligament clear of the articulation in flexion of the leg. use on knee and hip-joints,

When the foot rests on the ground, the semimembranosus acts on the pelvis like the other hamstring muscles. on pelvis.

The GREAT SCIATIC NERVE (fig. 53, 2) lies on the adductor magnus muscle below the buttock, and divides into the two popliteal nerves about the middle of the thigh, though its point of bifurcation may be carried upwards as far as the pelvis. In this extent the nerve lies along the outer border of the semimembranosus, and is crossed by the long head of the biceps. Great sciatic nerve in the thigh

Branches. Near the buttock it supplies large branches to the flexor muscles, and a small one to the adductor magnus. supplies muscles.

SMALL SCIATIC NERVE (fig. 53, 1). Between the gluteus maximus and the ham this small nerve is close beneath the fascia; but it becomes cutaneous below the knee, and accompanies the external saphenous vein for a short distance. Small sciatic in the thigh:

Small *cutaneous* filaments pierce the fascia; and the largest of these arises near the popliteal space. cutaneous offsets.

Dissection. To see the posterior surface of the adductor magnus, and the branches of the perforating and anastomotic arteries at the back of the thigh, the hamstring muscles must be detached from the hip-bone and thrown down; and the branches of arteries and nerves they receive are to be dissected out with care. All the parts are to be cleaned. Detach the hamstrings.

ADDUCTOR MAGNUS MUSCLE (fig. 53, c). At its posterior aspect the large adductor is altogether fleshy, even at the opening in the lower third of the thigh, where the superficial femoral passes through it to become the popliteal; and the upper fibres which come from the pubic arch appear to form a part almost distinct from those connected with the tuberosity of the ischium. In contact with this surface are the hamstring muscles and the great sciatic nerve. (The muscle will be described later in the dissection of the thigh from the front, p. 167.) Posterior surface of adductor magnus.

END OF THE PERFORATING ARTERIES (fig. 53, *c*, *d*, *e*). These branches of the profunda femoris appear through the adductor magnus close to the femur, and are directed outwards through the short head of the biceps and the outer intermuscular septum to the vastus externus and crureus muscles; but as the first branch is placed higher than the attachment of the biceps, it pierces the gluteus maximus in its course. In the extensor muscles they anastomose together, and with the transverse and descending branches of the external circumflex artery. Perforating arteries: course and ending;

Muscular branches are furnished by the perforating arteries to the heads of the biceps; and a cutaneous offset is given by each to the integuments of the outer side of the thigh, along the line of the outer intermuscular septum. offsets to biceps and the skin.

Muscular branches: number and course.

MUSCULAR BRANCHES OF THE PROFUNDA (fig. 53, *f*), pierce the adductor magnus internal to the preceding, and at some distance from the femur (p. 166). Three or four in number, the highest appears about five inches from the pelvis, and the rest in a line at intervals of about two inches from one another: they are distributed to the hamstring muscles, especially the semimembranosus, and communicate below with offsets of the popliteal trunk.

Dissection. The muscles are to be taken away from the back of the hip-joint and the areolar tissue removed from the back of the capsule, so as to prepare for the dissection of the joint at a later stage.

CHAPTER IV.

DISSECTION OF THE LOWER LIMB.

SECTION I.

THE FRONT OF THE THIGH.

Position. During the dissection of the front of the thigh the body lies on the back, with the buttocks resting on the edge of the table, and with a block of suitable size beneath the loins. The lower limb should be stretched out on the table, slightly flexed at the knee and rotated outwards to make evident a hollow at the top of the thigh. Position of the body.

Surface-marking. Before any of the integument is removed from the limb, the student should observe the chief eminences and hollows on the surface of the thigh. Objects on the surface.

The limit between the thigh and abdomen is marked, in front, by the firm band of Poupart's ligament reaching from the anterior superior spine of the ilium to the pubis. On the outer side, the separation is indicated by the convexity of the iliac crest of the hip-bone, which subsides behind in the sacrum and coccyx. Internally is the projection of the pubis, from which the bony margin of the subpubic arch may be traced backwards, forming the inner boundary of the limb, to the ischial tuberosity. Limits of the thigh above.

On the anterior aspect of the thigh, and close to Poupart's ligament, is a slight hollow, corresponding with the triangular space of Scarpa, in which the larger vessels of the limb are contained; and extending thence obliquely towards the inner side of the limb, is a slight depression marking the situation of the femoral artery beneath. The position of the arterial trunk is marked by the upper three-fourths of a line drawn from the centre of the interval between the symphysis pubis and the anterior superior iliac spine to the inner condyle of the femur. Hollow of Scarpa's triangle. Groove over femoral artery.

At the outer side of the hip, from three to four inches below and behind the anterior part of the iliac crest, will be recognised the well-marked projection of the great trochanter of the femur. In a thin body the head of the femur may be felt by rotating the limb inwards and outwards, while the thumb of one hand is placed in front in the hollow below Poupart's ligament, and the fingers behind the great trochanter. Position of great trochanter. Head of the femur.

At the knee the outline of the several bones entering into the formation of the joint may be traced with ease. In front of the Bony eminences of knee:

patella ; joint, when it is half-bent, the rounded prominent patella may be perceived ; this bone is firmly fixed while the limb is kept in the bent position, but is moved with great freedom when the joint is extended, so as to relax the muscles inserted into it. On each side of the patella is the projection of the condyle of the femur, that on the inner side being the larger. If the fingers are passed along the sides of the patella while the joint is half bent, they will be conducted to the tuberosities of the head of the tibia, and to a slight hollow between it and the femur.

condyles of the femur ;

tuberosities of the tibia.

The ham behind. Behind the joint is a slight depression over the situation of the ham or popliteal space ; and on its sides are firm boundaries, which are formed by the tendons (hamstrings) of the flexor muscles of the knee.

Dissection. **Dissection.** The limb being placed as before directed, the student begins the dissection with the examination of the subcutaneous fatty tissue with its nerves and vessels.

Take up skin at the top of the thigh. At first the integument is to be reflected only from the hollow on the front of the thigh below Poupart's ligament. An incision about five inches in length, and only skin deep, is to be made from the pubis along the inner border of the thigh (fig. 1, B, [9], p. 3). At the lower end of the first incision, another cut is to be directed outwards across the front of the limb to the outer aspect ([10]) ; and, at the upper end, the knife is to be carried along the line of Poupart's ligament as far as the crest of the ilium. The piece of skin included by these incisions is to be raised and turned outwards, without taking with it the subcutaneous fat.

Superficial fascia : how formed ; The subcutaneous fatty tissue, or the *superficial fascia*, forms a general investment for the limb, and is constructed of a network of areolar tissue, with fat or adipose substance amongst the meshes. As a part of the common covering of the body, it is continuous with that of the neighbouring regions ; consequently it may be followed inwards to the scrotum or the labium according to the sex, and upwards on the abdomen. Its thickness varies in different bodies, according to the quantity of fat in it ; and when well developed it may be divided into separate layers. Its relations will be made more evident by the following dissection.

thickness varies.

To raise the superficial fascia. **Dissection.** To reflect the superficial fascia, incisions similar to those made in the skin are to be employed ; and the separation from the subjacent structures is to be begun below, where the large saphenous vein, and a condensed or membranous appearance on the under surface, will mark the depth of the stratum. The layer of fat may be thrown outwards readily by a few touches of the knife, when the superficial vessels and inguinal lymphatic glands will come into view.

Relations of superficial fascia. The *subcutaneous layer* decreases in thickness, and becomes more fibrous near Poupart's ligament ; and on its under aspect it has a smooth and membranous surface. It conceals the superficial vessels and the inguinal glands, and is separated by these from Poupart's ligament.

Dissection **Dissection** (fig. 54). The inguinal glands and the superficial vessels are next to be cleaned by the removal of any surrounding

fat; but the student is to be careful not to destroy a deeper, very thin layer of areolar tissue which is beneath them, and is visible on the inner side of the centre of the limb. Three sets of vessels are to be dissected out :—One set (artery and vein) is directed inwards to the pubes, and is named *superficial external pudic;* another, to see the superficial vessels,

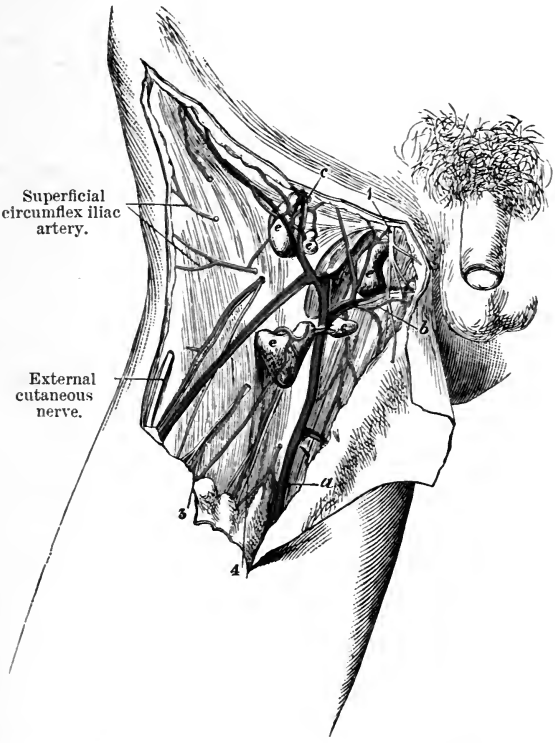


FIG. 54.—DISSECTION OF THE SUPERFICIAL PARTS OF THE THIGH (ILLUSTRATIONS OF DISSECTIONS).

Vessels :

a. Internal saphenous vein.
b. Superficial external pudic.
c. Superficial epigastric.
d. Superficial circumflex iliac.
e. Inguinal glands.
f. Saphenous opening.

Nerves :

1. Ilio-inguinal.
2. External cutaneous.
3. Genito-crural.
4. Middle cutaneous. Small unnamed vessels accompany the different nerves to the integuments.

superficial epigastric, ascends over Poupart's ligament; and the third, the *superficial circumflex iliac*, appears at the outer part of the limb. The large vein towards the inner side of the thigh, to which the branches converge, is the *internal saphenous.*

Some of the small lymphatic vessels may be traced from one inguinal gland to another. lymphatics

and nerves. A small nerve, the *ilio-inguinal*, is to be sought on the inner side of the saphenous vein, close to the pubis; and a branch of the *genito-crural* nerve may be found a little outside the vein.

The arteries from the femoral. SUPERFICIAL VESSELS. The small cutaneous arteries at the top of the thigh are the first branches of the femoral trunk, they pierce the deep fascia (fascia lata), and are distributed to the integuments and the glands of the groin and neighbourhood.

One external pudic artery; The SUPERFICIAL EXTERNAL PUDIC ARTERY (superior; fig. 54, *b*) crosses the spermatic cord in its course inwards, and ends in the integuments of the penis and scrotum, where it anastomoses with offsets of the internal pudic artery.

another beneath the fascia. Another external pudic branch (deep; p. 149) pierces the fascia lata at the inner border of the thigh, and ramifies also in the scrotum. In the female both branches supply the labium pudendi.

Superficial epigastric. The SUPERFICIAL EPIGASTRIC ARTERY (*c*) passes over Poupart's ligament to the abdomen, and communicates with branches of the deep epigastric artery.

Superficial circumflex iliac. The SUPERFICIAL CIRCUMFLEX ILIAC ARTERY frequently arises in common with the foregoing and is the smallest of the three branches; appearing as two or more pieces at the upper part of the thigh near the iliac crest, it is distributed in the integuments: it supplies an offset with the external cutaneous nerve.

Veins join the saphenous. A *vein* accompanies each artery, having the same name as its companion vessel, and ends in the upper part of the saphenous vein, with the exception of that with the deep external pudic artery: these veins will be noticed directly.

Inguinal glands: two sets, The SUPERFICIAL INGUINAL GLANDS (*e*) are arranged in two lines. An upper set lies across the thigh, near Poupart's ligament; and a lower set is situate along the side of the saphenous vein. In the lower or *femoral group* the glands are larger than in the upper, and

which receive different lymphatics. the lymphatic vessels from the surface of the lower limb enter them. The upper or *inguinal group* is joined by the lymphatics of the penis, by those of the surface of the abdomen, and by those of the buttock. The glands vary much in number and size; and not unfrequently some of the longitudinal set by the side of the vein are blended together.

Cribriform fascia is *Cribriform fascia.* Beneath, and to the inner side of, the internal saphenous vein there is a thin layer of areolar tissue, which is sometimes described as a special deeper layer of the superficial fascia. This

an areolar membrane over saphenous opening: stratum is continued across the aperture in the deep fascia (saphenous opening; fig. 54, *f*) through which the vein disappears; and being there perforated by many large lymphatic vessels, as well as by the saphenous vein, the name cribriform fascia has been given to this part. The cribriform fascia is closely united to the outer margin of the saphenous opening; and it is also adherent to the subjacent crural sheath of the vessels in the aperture. In a hernial protrusion through the saphenous opening, the cribri-

relation to femoral hernia. form fascia is stretched and pushed forwards by the tumour, and forms one of the coverings.

Dissection. After having observed the disposition of the superficial fascia near Poupart's ligament, the student may proceed to examine the remainder of the subcutaneous covering of the thigh, together with the vessels and nerves in it. Dissection of the front of the thigh.

To raise the skin from the front of the thigh, a cut is to be carried along the centre of the limb, over the knee-joint, to rather below the tubercle of the tibia. At the extremity of this a transverse incision is to be made across the front of the leg, but this is to reach farthest on the inner side. The skin may be reflected in flaps inwards and outwards; and as it is raised from the front of the knee, a superficial bursa between it and the patella will be opened. Take away the skin,

The saphenous vein is to be first traced out in the fat as far as the skin is reflected, but in removing the tissue from it the student should be careful of branches of the internal cutaneous nerve. and follow saphenous vein.

The cutaneous nerves of the front of the thigh (fig. 55, p. 140) are to be sought in the fat, with small cutaneous arteries, in the following positions:—On the outer margin, below the upper third, is placed the *external cutaneous* nerve. In the middle of the limb, below the upper third, lie the two branches of the *middle cutaneous* nerve. At the inner margin are the ramifications of the *internal cutaneous* nerve—one small offset appearing near the upper part of the thigh, one or more about half-way down, and one of the terminal branches (anterior) about the lower third. Seek cutaneous nerves of front of thigh,

On the inner side of the knee three other cutaneous nerves are to be looked for:—One, a branch of the *great saphenous*, is directed outwards over the patella. Another, the trunk of the great saphenous nerve, lies by the side of the vein of the same name, close to the lower edge of the surface now dissected. And the third is a terminal branch (posterior) of the internal cutaneous nerve, which is close behind the preceding, and communicates with it. and on side of the knee.

Vessels. All the cutaneous veins on the anterior and inner aspects of the thigh are collected into one; and this trunk is named saphenous from its manifest appearance on the surface. Superficial veins.

The INTERNAL SAPHENOUS VEIN (fig. 54, *a*) is the cutaneous trunk of the inner side of the lower limb, and extends from the foot to the top of the thigh. In the part of its course now dissected, the vessel lies inferiorly somewhat behind the knee-joint; but as it ascends to its termination, it is directed along the inner side and the front of the thigh. Near Poupart's ligament it pierces the fascia lata by a special opening named saphenous, and enters the deep vein (femoral) of the limb. Internal saphenous vein in thigh pierces fascia lata to join the femoral.

Superficial branches join it both externally and internally; and near Poupart's ligament the three veins corresponding with the arteries in that situation, viz., superficial external pudic, superficial epigastric, and superficial circumflex iliac, terminate in it. Towards the upper part of the limb the veins of the inner side and back of the thigh are frequently united into one branch, which enters the saphenous trunk near the aperture in the fascia lata; and sometimes those on the outer side of the thigh are collected together in Veins joining it: may be three trunks at the top of the thigh.

a similar way. When this arrangement exists three large veins will be present on the front of the thigh, near the saphenous opening. On the side of the knee the vein receives a communicating branch from the deep veins.

Cutaneous arteries.

Some unnamed *cutaneous arteries* are distributed to the integuments along with the nerves; and the superficial branch of the anastomotic artery (p. 154) accompanies the saphenous nerve and its branches near the knee.

Cutaneous nerves.

NERVES. The cutaneous nerves of the thigh are derived from branches of the lumbar plexus, and in greater number on the inner than the outer side.

Ilio-inguinal is near scrotum.

ILIO-INGUINAL. This nerve is small, and reaches the surface by passing through the external abdominal ring (fig. 55, 7); it supplies the scrotum, and ends on the adjacent part of the thigh, internal to the saphenous vein.

Genito-crural reaches the middle of thigh:

GENITO-CRURAL. The *crural branch* of this nerve from the first and second lumbar nerves, pierces the fascia lata near Poupart's ligament (fig. 55, 6) rather external to the line of the femoral artery. After or before the nerve has become superficial it communicates with the middle cutaneous nerve; and it extends on the anterior aspect of the thigh as far as midway between the knee and the pelvis.

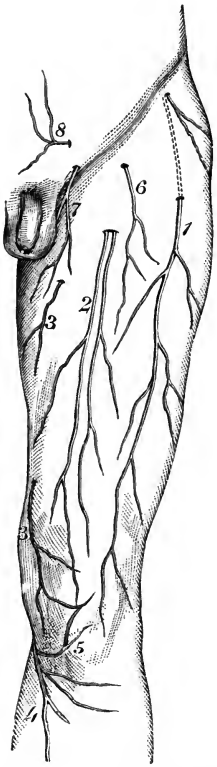


FIG. 55.—CUTANEOUS NERVES ON THE FRONT OF THE THIGH.

1. External cutaneous.
2. Middle cutaneous.
3. Internal cutaneous.
4. Internal saphenous.
5. Patellar branch of saphenous.
6. Genito-crural.
7. Ilio-inguinal.
8. Ilio-hypogastric on the belly.

unusual state.

Occasionally this branch is of large size, and takes the place of the external cutaneous nerve on the outer side of the limb.

External cutaneous,

The EXTERNAL CUTANEOUS NERVE from the second and third lumbar nerves ramifies on the outer aspect of the limb (fig. 55, 1). At first it is contained in a prominent ridge of the fascia lata on the outer margin of the thigh, where it divides into an anterior and a posterior branch.

posterior, and

The *posterior branch* subdivides into two or three others, which arch backwards to supply the integuments half-way down the outer side of the thigh.

anterior branches.

The *anterior branch* appears on the fascia lata about four inches from Poupart's ligament and is continued to the knee below the

other; it distributes branches laterally, but those towards the posterior surface are more numerous, and larger.

Middle cutaneous

MIDDLE CUTANEOUS (fig. 55, 2). The nerve of the centre of the thigh is a cutaneous offset of the anterior crural (p. 160), and divides into two branches. It is transmitted through the fascia lata about three inches from Poupart's ligament, and its branches are continued to the knee. In the fat this nerve is united with the genito-crural and internal cutaneous nerves.

reaches the knee.

Internal cutaneous :

INTERNAL CUTANEOUS. This nerve is derived from the anterior crural trunk, and is divided into two branches (anterior and posterior) which perforate the fascia at separate places.

the anterior branch

The *anterior branch* becomes cutaneous in the lower third of the thigh, in the line of the inner intermuscular septum (fig. 55, 3), along which it is continued to the knee. It is distributed in the lower third of the thigh, as well as over the patella and the inner side of the knee-joint, and is united with the patellar branch of the internal saphenous nerve (fig. 55, 5).

extends to knee;

the posterior ends in the leg;

The *posterior branch* (fig. 71, 8, p. 188) perforates the fascia on the inner side of the knee, behind the internal saphenous nerve, with which it communicates; it furnishes offsets to the upper half of the leg, on the inner surface.

other small twigs to the thigh.

Other small offsets of the nerve supply the inner side of the thigh, and appear by the side of the saphenous vein. One or two come into view near the top of the vein, and reach as far as the middle of the thigh; and one, larger than the rest, becomes cutaneous where the others cease, and extends as far as the knee.

Internal saphenous

The INTERNAL SAPHENOUS NERVE (fig. 55, 4), a branch of the anterior crural, is continued to the foot, but only a small part of it is now visible. It pierces the fascia close below the knee on the inner side; and after communicating with the inner branch of the internal cutaneous, gives forwards some offsets over the head of the tibia. Finally, it accompanies the saphenous vein to the leg and foot.

passes to the leg;

a branch on patella

Its *patellar branch* (fig. 55, 5) appears on the inner side of the knee above the preceding, and is soon joined by the internal cutaneous nerve. It ends in many branches over the patella; these communicate with offsets from the middle and internal cutaneous nerves, and form a network (*patellar plexus*) over the joint.

forms a plexus.

Clean the fascia lata,

Dissection. Let the fat and the inguinal glands be now removed from the surface of the fascia lata, the cutaneous nerves being thrown aside to be traced afterwards to their trunks.

and define saphenous opening.

At the upper part of the thigh the cribriform fascia is to be removed with great care so as to show the saphenous opening, without injury to the subjacent crural sheath; and on the other side of the aperture a semilunar border is to be defined by dividing the fibrous bands that unite it to the front of the sheath.

Fascia lata surrounds limb.

THE FASCIA LATA is the deep aponeurosis of the thigh. It is of a bluish-white colour, and surrounds the limb with a firm sheath; but in fat bodies it is sometimes so slight as to be taken away with the subcutaneous fat.

Ilio-tibial band.

It is strongest on the outer aspect of the limb, where it receives the insertion of the tensor vaginæ femoris, and most of the gluteus maximus muscle. This thickened part (*ilio-tibial band*) is attached above to the hip-bone, and below to the outer tuberosity of the tibia and the outer side of the patella, and helps to keep the knee-joint straight in standing, as explained on p. 113.

Apertures in fascia.

Numerous apertures exist in the fascia for the transmission of the cutaneous nerves and vessels ; and the largest hole is near Poupart's ligament, to permit the passage of the internal saphenous vein.

Processes between the muscles.

Processes prolonged from the deep surface form septa between, and fibrous sheaths around, the several muscles. Two of the processes are larger than the rest, and are named outer and inner *inter-muscular septa* of the thigh ; they are fixed to the femur, so as to limit on the sides the extensor of the knee. The position of these partitions is marked by white lines on the surface.

Connected with bone at upper part of thigh,

At the top of the thigh the fascia is fixed to the prominent borders of the pelvis. Thus, it is connected externally with the iliac crest, and internally with the body of the pubis and the margin of the pubic arch. Behind, it is joined to the lower end of the sacrum and coccyx ; and in front, to Poupart's ligament between the pubis and the iliac crest. Behind the knee-joint the fascia passes un-

difference at lower part.

interruptedly to the leg ; but in front of the articulation it blends with an expansion from the extensor muscle, and is continued over the joint and the patella, though separated from that bone by a bursa, to be inserted into the heads of the tibia and fibula.

Bands on sides of patella ; outer strong,

On each side of the patella is a band of almost transverse fibres (retinaculum), which is attached to and supports the knee-cap. The outer, thick and strong, is continuous externally with the ilio-tibial band, and joins the insertion of the vastus externus at its attachment to the patella : it guides the patella outwards when the joint is bent. The inner band, of slight strength, is fixed to the

inner weak.

patella lower than the other, and unites with the insertion of the inner vastus.

Replace flaps of skin.

Directions. The flaps of skin which were removed from the front of the thigh, to follow the cutaneous vessels and nerves, are to be now stitched together to keep moist the subjacent parts ; and the saphenous opening is to be learnt.

Saphenous opening : situation and size ;

The SAPHENOUS OPENING in the fascia lata (fig. 54, *f*, p. 137), is an oval aperture, which is situate rather internal to the middle line of the thigh. It measures about half an inch in width, and one inch and a half in length. Its upper extremity (superior cornu) is at Poupart's ligament ; and its lower extremity (inferior cornu) is distant from that structure about one inch and a half, and presents (when dissected) a well-defined margin.

no defined border on inner side ;

Internally, the saphenous opening has not any distinct margin, for the membrane here (called the *pubic portion of the fascia lata*) is continued outwards over the subjacent muscle (pectineus), and behind the femoral vessels, to form the back of the crural sheath.

on outer side the falciform margin,

Externally, the fascia lata (*iliac portion*) forms a semilunar border, when detached, the concavity of which is turned downwards and

inwards. This edge is named from its shape the *falciform margin* of the saphenous opening (falciform process of Burns); it is superficial to the femoral vessels, and is connected by fibrous bands to the crural sheath, and to the cribriform fascia. Traced upwards, the outer edge blends with the base of Gimbernat's ligament (part of Poupart's ligament): and the upper end of this border, where it is internal to the subjacent femoral vein, has been named the *femoral ligament.*

which joins Gimbernat's ligament, and forms femoral ligament;

The rigidity of the margin of the opening is much influenced by the position of the limb: for with the finger beneath the upper part of the falciform border, while the thigh is moved in different directions, this band will be perceived to be most unyielding when the limb is extended and rotated outwards, and most relaxed when the thigh is bent and turned in the opposite direction.

tenseness of the margin varies.

Through the lower cornu of the opening the saphenous vein is transmitted; and through the upper part, close to the falciform edge, a femoral hernia projects. Lymphatics and one or two superficial arteries also pass through it.

Parts transmitted through the opening.

PARTS CONCERNED IN FEMORAL HERNIA.

To understand the anatomy of a hernial protrusion in the thigh, the dissector has to study the undermentioned parts, viz., the crural arch and Gimbernat's ligament, the crural sheath with its crural canal and ring, together with a partition (septum crurale) between the thigh and the abdomen.

Anatomy of femoral hernia.

Dissection (fig. 56). To examine Poupart's ligament and the membranous sheath round the femoral vessels, the piece of the fascia lata outside the saphenous opening is to be reflected inwards by the following incisions:—One cut is to be begun near the upper end of the falciform border, and to be carried outwards for one inch and a half, parallel with and close to Poupart's ligament. Another is to be directed obliquely downwards and inwards from the termination of the first, to a little below the inferior cornu of the opening. When the triangular piece of fascia marked out by those incisions has been raised and turned inwards, and the fat removed, the tube on the vessels (crural sheath) will be brought into view as it descends beneath Poupart's ligament.

Dissection of femoral sheath.

With the handle of the scalpel the crural sheath is to be separated carefully from Poupart's ligament in front, and from Gimbernat's ligament on the inner side.

Poupart's ligament or the *crural arch* (fig. 56, c) is the firm band of the aponeurosis of the external oblique muscle of the abdomen, which stretches from the front of the iliac crest to the pubis. When viewed on the surface the arch is curved downwards towards the limb, so long as the fascia lata remains on the thigh. The outer half is oblique. But the inner half is almost horizontal, and widens as it approaches the pubis, where it is inserted into the pubic spine and pectineal line of the hip-bone, forming Gimbernat's ligament (fig. 97, p. 263).

Crural arch: attachments; form;

parts closing hollow beneath.

The space between the crural arch and the hip-bone is larger in the female than in the male, and is closed by parts passing from the abdomen to the thigh. The outer half of the interval is filled by the psoas and iliacus muscles, between which is the anterior crural nerve, while the external cutaneous nerve lies on the iliacus near the anterior superior iliac spine : in this part Poupart's ligament is closely bound down to the muscle by its attachment to the iliac fascia. The inner half is occupied by the femoral vessels and

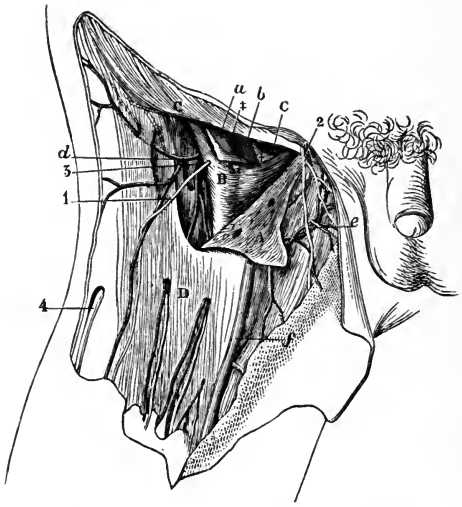


Fig. 56.—Dissection of the Crural Sheath (Illustrations of Dissections).

A. Iliac part of the fascia lata, reflected.
B. Crural sheath, opened.
C. Poupart's ligament.
D. Fascia lata of the thigh in place.
‡. Two septa dividing the space of the crural sheath into three compartments.

Vessels :

a. Femoral artery, and *b*, femoral vein, enclosed in the crural sheath with *c*, a lymphatic gland.
d. Superficial circumflex iliac.
e. Superficial pudic.
f. Saphenous vein.

Nerves :

1. Genito-crural.
2. Ilio-inguinal.
4. External cutaneous.

their sheath, with the upper end of the pectineus muscle ; the crural branch of the genito-crural nerve issues on the outer side of the artery.

Gimbernat's ligament :

Gimbernat's ligament, or the piece of the tendon of the external oblique muscle which is inserted into the pectineal line, is about three-fourths of an inch in length, and is triangular in shape (fig. 97).

form and relations.

Its apex is at the pubic spine : while its base is in contact with the crural sheath, and is joined by the falciform ligament of the fascia lata. By one margin (anterior) it is continuous with the crural

arch, and by the opposite it is fixed to the pectineal line. In the erect position of the body the ligament is almost horizontal.

Crural sheath: shape and relations:

The *crural* or *femoral sheath* (fig. 56, B) is a loose tube of membrane around the femoral vessels. It has the form of a funnel, sloped unequally on the sides. The wide part of the tube is upwards; and the narrow part ceases about two inches below Poupart's ligament, by blending with the common areolar sheath of the blood-vessels. Its outer border is nearly straight, and is perforated by the genito-crural nerve (1). Its inner border is oblique, and is pierced by lymphatics, superficial vessels, and the saphenous vein (*f*); this part of the sheath appears in the saphenous opening, and is connected to the falciform margin and the cribriform fascia. In front of the crural sheath is the iliac part of the fascia lata.

how formed.

The sheath is continuous with the fasciæ of the abdomen and thigh in this way. The anterior part is a prolongation under Poupart's ligament of the transversalis fascia lining the anterior abdominal wall; and the posterior part is formed externally by the iliac fascia covering the psoas muscle, and internally by the pubic part of the fascia lata covering the pectineus.

Deep crural arch.

Crossing the front of the sheath, beneath the arch of Poupart's ligament, is a fibrous band, the *deep crural arch*, which will be noticed later on in the description of the transversalis fascia.

Open the crural sheath.

Dissection (fig. 56). The student is to now open the crural sheath by an incision across the front, and to raise the anterior part with hooks. Inside the tube are contained the femoral vessels, each surrounded by its covering of areolar tissue, together with an inguinal gland; and if a piece of the areolar casing be cut out over both the artery and the vein, there will be an appearance of two thin partitions, the one being situate on the inner side of the vein, separating this vessel from the gland, and the other (‡) between the vein and the artery.

Vessels have areolar sheath.

Contents of crural sheath.

Interior of the crural sheath. The sheath is said to be divided into three compartments by two partitions; and the position of the so-called septa has been before referred to—one being internal to the femoral vein, and the other between the two large vessels. In the outer compartment is contained the femoral artery (*a*), lying close to the side of the sheath; in the middle one is placed the femoral vein (*b*); and in the inner space (*crural canal*) only a lymphatic gland (*c*) is situated.

Space divided into three:

the inner is the crural canal;

The *crural canal* (fig. 56) is the innermost space in the interior of the crural sheath:—Its length is about a third of an inch, and it reaches from the base of Gimbernat's ligament to the upper cornu of the saphenous opening. It decreases rapidly in size from above down, and is closed below. The aperture by which the space communicates with the cavity of the abdomen is named the *crural ring*.

parts around it.

In front of the canal are Poupart's ligament and the upper end of the falciform margin of the saphenous opening; while behind it is the pectineus muscle. On the outer side of the canal, but within the sheath, is the femoral vein. Through this channel the intestine passes from the abdomen in femoral hernia.

Crural ring: The *crural ring* is the upper opening of the crural canal. It is on a level with the base of Gimbernat's ligament, and is larger in situation and form; the female than in the male. Oval in shape, its greatest measurement is from side to side, in which direction it equals about half an inch; and it is filled by a lymphatic gland.

boundaries. The structures around the ring are the superficial and the deep crural arch in front, and the pubis covered by the pectineus muscle behind. Internally is Gimbernat's ligament with the conjoined tendon; and externally (but within the sheath) is the femoral vein.

Crural septum: *Septum crurale.* That part of the subperitoneal fatty layer which is placed over the abdominal entrance to this crural canal has been named crural septum from its position between the thigh and abdomen. The situation of the septum is now visible, but its characters will be ascertained in the dissection of the abdomen.

Femoral hernia: definition; FEMORAL HERNIA. In this kind of hernia there is a protrusion of intestine into the thigh beneath Poupart's ligament. And the gut descends in the crural sheath, being placed on the inner side of the vein.

course; *Course.* At first the intestine takes a vertical direction in its progress from the abdomen, and passes through the crural ring, and first vertical, along the crural canal as far as the saphenous opening. At this next forwards, and then upwards, spot it changes its course, and is directed forwards to the surface of the thigh, where it becomes elongated transversely; and should the gut protrude still farther, the tumour ascends on the abdomen, in consequence of the resistance being less in this direction than on the front of the thigh.

How it is to be pushed back. The winding course of the hernia may suggest to the dissector the direction in which attempts should be made to replace the intestine in the abdominal cavity. With the view of making the bowel retrace its course, it will be necessary, if the protrusion is small, to direct it backwards and upwards; but if the hernia is large, it must be pressed down first to the saphenous opening, and afterwards backwards and upwards towards the crural canal and ring.

During the manipulation to return the intestine to its cavity, the thigh is to be raised and rotated inwards, in order that the margin of the saphenous opening and the other structures may be relaxed.

SCARPA'S TRIANGULAR SPACE.

Triangular space. This hollow is situate on the front of the thigh, and lies beneath the superficial depression seen near Poupart's ligament.

Clean out Scarpa's space, **Dissection** (fig. 57, p. 147). The space will appear on removing the fascia lata near Poupart's ligament. The muscular boundaries on the sides may be first dissected, and the muscle on the outer Follow vessels, side (sartorius) should be fixed in place with stitches. Afterwards the remains of the crural sheath are to be taken away; and the femoral vessels are to be followed downwards as far as the sartorius seek nerves, muscle. On the outer side of the vessels clean the divisions of the

anterior crural nerve which lie immediately external to the artery, together with the branches of a deep branch of the artery (*profunda femoris*) which are buried in the fat. In removing the fat from take away fat.

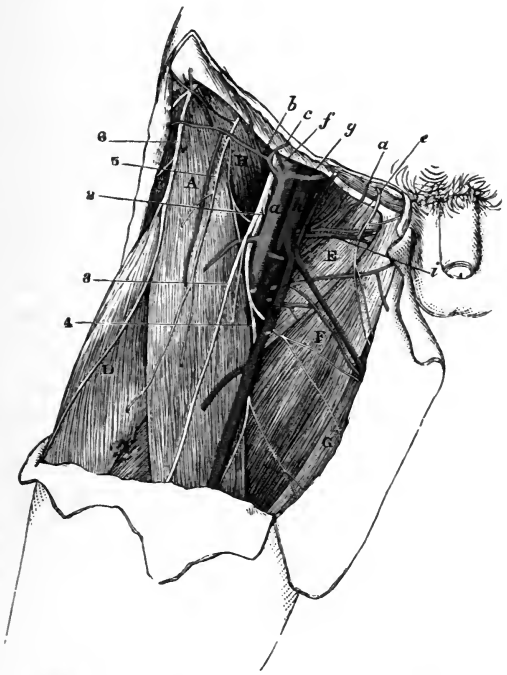


FIG. 57.—DISSECTION OF SCARPA'S TRIANGULAR SPACE (ILLUSTRATIONS OF DISSECTIONS).

Muscles :

A. Sartorius (unusually large in this dissection).
B. Iliacus.
C. Tensor fasciæ latæ.
D. Rectus femoris.
E. Pectineus.
F. Adductor longus.
G. Gracilis.

Vessels :

a. Common femoral artery.
b. Superficial circumflex iliac.
c. Superficial epigastric.
e. Superficial external pudic.
f. Deep circumflex iliac.
g. Deep epigastric.
h. Femoral vein.
i. Inferior external pudic vein.
k. Internal saphenous vein.

Nerves :

The large anterior crural is close outside the artery.
2. Offset to the pectineus.
3. Middle cutaneous.
4. Internal cutaneous.
5. Genito-crural.
6. External cutaneous.

behind the femoral artery, the student is to look for one or two small nerves to the pectineus muscle, which pass inwards about an inch below Poupart's ligament.

SCARPA'S TRIANGLE (fig. 57) is an intermuscular space containing Contents;

extent; the trunks of the blood-vessels of the thigh, and the anterior crural nerve, with lymphatics and fat. It extends commonly over the upper third of the thigh; but the length varies with the breadth of the sartorius, and the height at which this muscle crosses inwards.

base and sides; The base of the space is at Poupart's ligament; externally it is bounded by the inner border of the sartorius; and internally by the inner border of the adductor longus.

roof and floor. Towards the surface it is covered by the fascia lata, and by the integuments with inguinal glands and superficial vessels. The floor slopes backwards on each side towards the middle of the space; it is constructed externally, where it is of small extent, by the conjoined psoas and iliacus (B); and internally by the pectineus and adductor longus muscles (E and F), between and behind which, near the large vessels, is a small piece of the adductor brevis.

Position of femoral artery; The femoral artery runs through the deepest part of the hollow, lying slightly outside the centre of the space, and supplies small cutaneous offsets, as well as a large deep branch, the profunda; and a small offset (external pudic) is directed from it to the scrotum across the inner boundary. On the inner side of the artery and

of vein: close to it is placed the femoral vein, which is here joined by the

of anterior crural nerve. saphenous and profunda branches. About a third of an inch external to the vessel is situate the large anterior crural nerve which lies deeply at first between the iliacus and psoas, but afterwards becomes more superficial and divides into branches.

Lymphatics. Deep lymphatics accompany the femoral vessels, and are continued into the iliac glands in the abdomen; they are joined by the superficial lymphatics.

Femoral artery: extent; FEMORAL ARTERY (fig. 57 and fig. 59, p. 153) This vessel is a continuation of the external iliac, and extends from the lower border of Poupart's ligament to the opening in the adductor magnus muscle; at that spot it passes into the ham, and takes the name of

course; *popliteal*. Occupying three-fourths of the length of the thigh, the course of the vessel will be indicated, during rotation outwards of the limb with the knee-joint half bent, by a line drawn from a point midway between the symphysis pubis and the anterior superior iliac spine, to the prominent tuberosity of the inner condyle of the femur.

position to femur and parts around; In the upper part of its course the artery lies rather internal to the head of the femur, and is comparatively superficial, being uncovered by muscle; but lower down it is placed along the inner side of the shaft of that bone, and is beneath the sartorius muscle.

division into two. This difference in its relations allows of a division of the arterial trunk into two portions, an upper, superficial, and a lower, deep.

Superficial portion: The upper part of the artery (fig. 57, *a*), which is now laid bare, is contained in Scarpa's triangular space, and is from three to four inches long. Its position in that hollow may be ascertained by the line before mentioned.

relations to parts around; Encased at first in the crural sheath for about two inches, it is covered by the skin and the superficial fascia, and by the fascia

lata and some inguinal glands. At its beginning the artery rests on the psoas muscle; and it is subsequently placed over the pectineus (E), though at some distance from the muscle in this position of the limb, and separated from it by fat, and the profunda and femoral veins.

position of vein and

Its companion vein (*h*) is on the inner side and close to it at the pubis, but is placed behind the artery lower down.

nerves.

The anterior crural nerve lies on the outer side, being distant about a third of an inch near Poupart's ligament; and the internal cutaneous branch of the nerve lies over the artery along the edge of the sartorius. Crossing beneath the vessels is the nerve of the pectineus (2).

Unusual position.

Unusual position. A few examples of transference of the main artery of the limb from the front to the back of the thigh have been recorded. In these cases the vessel passed from the pelvis through the great sacro-sciatic foramen, and accompanied the great sciatic nerve to the popliteal space.

Branches:—

The BRANCHES of the artery in Scarpa's triangle are the superficial epigastric and circumflex iliac, two external pudic, and the deep femoral branch. The cutaneous offsets have been seen (p. 138), with the exception of the following, which lies at first beneath the fascia lata.

An external pudic.

The *deep external pudic artery* (fig. 57, *e*) arises separately from, or in common with, the other pudic branch. It courses inwards over the pectineus muscle, and perforates the fascia lata at the inner border of the thigh to end in the scrotum or labium pudendi, according to the sex: in the fat it anastomoses with branches of the superficial perineal artery.

The portion of the artery above the origin of the DEEP FEMORAL is called the COMMON FEMORAL, and the part below is styled the SUPERFICIAL FEMORAL to distinguish it from the deep.

Profunda:

The DEEP FEMORAL ARTERY or the *profunda femoris* (fig. 59,2) arises from the outer side of the common femoral trunk from one or two inches below Poupart's ligament. Its distribution is to the muscles of the thigh, and will be afterwards followed. In the present dissection it may be seen to lie over the iliacus muscle, where it gives the external circumflex artery to the outer part of the thigh; and then to turn, with a large vein, beneath the trunks of the superficial femoral vessels to the inner side of the limb.

origin, and position in Scarpa's triangle;

origin of profunda varies.

Variation in origin. The origin of the profunda may approach nearer to Poupart's ligament until it arrives opposite that band; or may even go beyond, and reach the external iliac artery (one example, R. Quain). And the branch may recede farther from the ligament, till it leaves the parent trunk at the distance of four inches from the commencement; but in this case the circumflex branches usually arise separately from the femoral. In applying a ligature to the femoral artery in the upper part of the thigh, the thread should be placed four inches below Poupart's ligament, in order that the spot chosen may be free from the disturbing influence of so large an offset.

Femoral vein; first inside the artery,

FEMORAL VEIN (fig. 57, *h*). The principal vein of the limb, while in Scarpa's triangle, has almost the same relative anatomy

as the artery, and is similarly named ; its position to that vessel, however, is not the same throughout. Beneath Poupart's ligament it is on the inner side of the arterial trunk, and on the same level, and is supported on the pubis between the psoas and pectineus muscles ; but it soon winds behind the artery, and is placed between the main trunk and its deep branch. In this space it receives the internal saphenous and deep femoral veins, and a small branch running with the deep external pudic artery.

afterwards behind it.

DEEP PARTS OF THE FRONT OF THE THIGH.

Muscles on the front of the thigh.

The muscles on the front of the thigh are to be learnt next : they are the sartorius and the extensor of the knee ; and at the upper end of the thigh is the small tensor of the fascia lata. Four muscles are combined in the extensor, viz., rectus, crureus, vastus externus, and vastus internus.

Vessels.

The external circumflex branch of the profunda artery lies amongst the muscles and supplies them with branches ; and a large

Nerve.

nerve, the anterior crural, furnishes offsets to them.

Take the fascia from the front of the thigh.

Dissection. To proceed with the deep dissection, the limb is to be retained in the same position as before, and the flaps of skin on the front of the thigh are to be thrown aside. The fascia lata is to be cut along the middle line of the thigh and knee, and to be reflected to each side nearly to the same extent as the skin. Over the knee-joint the student is to note its attachment to the edges of the patella, and its union with a prolongation from the tendon of the extensor muscle of the knee.

Follow out sartorius, and fix it,

In raising the inner piece of the fascia, the narrow *sartorius* muscle should be followed to its insertion into the tibia ; and to prevent its displacement it should be fixed with stitches along both edges. Care should be taken of the small nerves in contact with the sartorius, viz., a plexus beneath it at the middle of the thigh from the saphenous, internal cutaneous and

and preserve nerves in contact with it.

obturator ; two branches of the internal cutaneous below its middle—one crossing the surface, and the other lying along the inner edge of the muscle ; and the trunk of the long saphenous nerve escaping from beneath it near the knee, with the patellar branch of the same perforating it rather higher.

Dissect the adductors,

Internal to the sartorius some strong muscles (adductors) are inclined downwards from the pelvis to the femur. The student is to lay bare the fore part of these muscles (fig. 58) ; and beneath the most superficial (adductor longus), near where it touches the sartorius, he is to seek a branch of the obturator nerve to the plexus before

and clean the extensor muscle.

mentioned in the middle of the thigh. On the outer side of the sartorius is the large extensor of the knee, in cleaning which the knee is to be bent, to make tense the fibres.

Dissect tensor of fascia.

The smaller muscle at the upper and outer part of the thigh (tensor fasciæ femoris) is also to be cleaned ; and a strip of the fascia, corresponding with the width of the muscle, should be left

along the outer aspect of the limb. After this slip has been isolated, the rest of the fascia on the outer side of the thigh is to be divided

FIG. 58.—SURFACE VIEW OF THE FRONT OF THE THIGH, THE INTEGUMENTS AND FASCIA LATA BEING REMOVED (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Sartorius.
B. Iliacus.
C. Tensor fasciæ femoris.
D. Rectus femoris.
E. Vastus internus.
F. Pectineus.
G. Adductor longus.
H. Gracilis.
I. Tendon of sartorius.

Vessels:

a. Femoral artery.
b. Femoral vein.
c. Internal saphenous vein.

by one or two transverse cuts, and is to be followed backwards to its insertion into the femur.

Sartorius: The SARTORIUS (fig. 58, A), is the longest muscle in the body, and extends from the pelvis to the leg. It arches over the front of the thigh, passing from the outer to the inner side of the limb, and lies in a hollow between the extensor on the one side, and the adductors on the other.

origin; Its *origin* is tendinous from the upper anterior iliac spinous process of the hip-bone, and from about half the interval between

course over the thigh; this and the inferior process (fig. 47, p. 113). The fibres constitute a riband-like muscle, which ends in a thin tendon below the knee,

insertion; and is *inserted* into the inner surface of the tibia (fig. 68, p. 179) —mainly into a slight depression by the side of the tubercle for an inch and a half, but also, by its upper edge, as far back as the internal lateral ligament of the knee-joint. From the lower part of the tendon also is an extension into the fascia of the leg.

relations of the first or oblique portion, The muscle is superficial throughout, and is perforated by some cutaneous nerves and vessels. Its upper part is oblique, and forms the outer boundary of Scarpa's triangle; it rests on the following muscles (fig. 58); iliacus (B), rectus (D), and adductor longus (G), as

of the middle, well as on the anterior crural nerve and the femoral vessels. The middle portion is vertical, and lies in a hollow between the vastus internus (E) and the adductor muscles, as low as the opening for the femoral artery; but beyond that aperture, where it bounds the popliteal space, it is placed between the vastus with the great adductor in front, and the gracilis (H) with the inner hamstrings behind. The femoral vessels and their accompanying nerves are

and of the lower part; concealed by the middle portion of the muscle. The lower tendinous part (I) rests on the internal lateral ligament of the knee-joint, being superficial to the tendons of the gracilis and semitendinosus, and separated from them by a prolongation of their synovial bursa: from its upper border there is an aponeurotic expansion to join that from the extensor over the knee; and from its lower border is given off another which blends with the fascia of the leg. Below the tendon the long saphenous nerve appears with vessels; and piercing it is the patellar branch of the same nerve.

use, the limb free, *Action.* The tibia and femur being free to move, the muscle bends the knee and hip-joints over which it passes, giving rise to rotation inwards of the tibia, and outwards of the femur.

and fixed; With the limbs fixed, the two muscles will assist in bringing forwards the pelvis in stooping; and when standing on one leg the

standing on one leg. muscle will help to rotate the body, so as to turn the face to the opposite side.

Divide the sartorius, **Dissection** (fig. 59). The sartorius is to be turned aside, or cut through if it is necessary, to follow the remaining part of the femoral artery.

show aponeurosis, Beneath the muscle is an aponeurosis between the adductor and

and dissect the nerves extensor muscles; this is thin above, and when it is divided the long, or internal, saphenous nerve will come into view. Parallel to the saphenous nerve above, but outside it, is the nerve to the vastus internus muscle, which sends an offset on the surface of the vastus to the knee-joint: the latter may be traced now, lest it should be

destroyed afterwards. The plexus of nerves on the inner side of the thigh may be more completely dissected at this stage.

3. Internal circumflex artery.
6. Deep external pudic.
5. Superficial circumflex iliac artery.
8. Anterior crural nerve.
2. Profunda femoris artery.
4. External circumflex artery.

FIG. 59.—DEEP PART OF THE FEMORAL ARTERY AND ITS BRANCHES, WITH MUSCLES OF THE THIGH (QUAIN'S ARTERIES).

1. Superficial femoral artery.
2. Deep femoral artery.
3. Internal circumflex artery.
4. External circumflex artery.
5. Superficial circumflex iliac artery.
6. Deep external pudic artery.
7. Lower part of the aponeurosis over the femoral artery.
8. Anterior crural nerve.
9. Pectineus muscle.
10. Adductor longus.
11. Gracilis.
12. Vastus internus.
13. Rectus femoris.
14. Sartorius, in part removed.

and vessels. The femoral vessels and their branches are to be carefully cleaned. Where the superficial femoral artery passes to the back of the limb its small anastomotic branch arises: this branch is to be pursued through the fibres of the vastus internus, and in front of the adductor magnus tendon, to the knee; an offset of it is to be followed with the saphenous nerve.

Aponeurosis over the femoral artery ends below by a free border. The *aponeurotic covering* of the femoral vessels (fig. 59, 7) exists where they are covered by the sartorius. It is thin above; but below it is formed of strong fibres, which are directed transversely between the vastus internus on the outer side and the tendons of the adductor muscles behind and to the inner side. Inferiorly, this membranous structure ceases at the opening in the adductor magnus by a defined border, beneath which the long saphenous nerve and the anastomotic vessels escape.

Femoral artery in Hunter's canal; relations; The SUPERFICIAL FEMORAL ARTERY (fig. 59, 1) beneath the sartorius muscle lies in a hollow between the muscles covered by the aponeurotic expansion just described, until it reaches the opening in the adductor magnus. The passage, thus formed, in which the artery lies, is called HUNTER'S CANAL. Beneath the artery are the pectineus and the adductor brevis in part, the adductor longus, and a small piece of the adductor magnus. On the outer side is the vastus internus.

position of veins and saphenous nerve. The vein lies close to the artery, on its posterior and outer aspect; and in the integuments oftentimes an offset of the saphenous passes across the line of the arterial trunk.

Lying along the front of the artery is the long saphenous nerve, which is beneath the aponeurosis before noticed, but is not contained within the areolar sheath of the vessels.

The femoral artery may be divided. *Splitting of the artery.* Occasionally the femoral artery is split into two below the origin of the profunda; but in all the cases that have been met with, the branches have united again above the opening in the adductor muscle.

Branches:— *Branches.* One named branch—anastomotic, and muscular offsets, spring from this part of the artery.

Anastomotic: The *anastomotic branch* (fig. 62, *k*, p. 165) arises close to the opening in the adductor muscle, and divides at once into two branches, superficial and deep:—

superficial, and The *superficial branch* (*n*) continues with the saphenous nerve to the lower border of the sartorius, and piercing the fascia lata, ramifies in the integuments.

deep part. The *deep branch* (*l*) is concealed in the fibres of the vastus internus, and descends in front of the tendon of the adductor magnus to the inner side of the knee-joint, where it anastomoses with the articular branches of the popliteal artery. A branch passes outwards from it in the substance of the vastus muscle, and forms an arch at the upper border of the patella with an offset of the superior external articular artery.

Muscular branches. *Muscular branches.* Branches for the supply of the muscles come mostly from the outer side of the superficial femoral artery; they enter the sartorius, the vastus internus, and the adductor longus.

The SUPERFICIAL FEMORAL VEIN corresponds closely with the femoral artery in its relations and its branches. Superficial femoral vein.

Dissection. The superficial femoral artery and vein are to be cut across just below the origin of the profunda, and are to be thrown downwards preparatory to the deeper dissection. Afterwards all the fat, and all *the veins*, are to be carefully removed from amongst the branches of the profunda artery and anterior crural nerve. Unless this dissection is fully carried out, the upper part of the vastus internus and crureus will not be prepared for examination. To expose muscles on front of the femur.

The TENSOR FASCIÆ FEMORIS *s.* FASCIÆ LATÆ (fig. 62, L, p. 165) occupies the upper third of the thigh. It takes *origin* from the front of the crest of the ilium at the outer aspect, from the anterior superior spine and from the edge of the notch between this and the inferior spine as far as the attachment of the sartorius (fig. 47, p. 113). Its fibres form a fleshy belly about two inches wide, and are *inserted* into the ilio-tibial band of the fascia lata about three inches below, and rather in front of the line of, the great trochanter of the femur. Tensor fasciæ femoris arises from pelvis; ends in fascia lata;

At its origin the muscle is situate between the sartorius and the gluteus medius. Beneath it are the ascending offsets of the external circumflex artery; and a branch of the superior gluteal nerve enters its under surface. A strong sheath of fascia surrounds the muscle. parts around;

Action. Supposing the limb moveable the muscle abducts the thigh, and may help in rotating inwards the femur. use on limb;

When the limb is fixed it will support the pelvis, and assist in balancing the latter on the femur in walking. on pelvis;

The chief function of the tensor vaginæ femoris is, however, to act with the gluteus maximus in tightening the ilio-tibial band so as to support the extended knee. on knee.

Dissection. After the tensor has been learnt, the slip of fascia extending from it to the knee may be cut through; and when it is detached from the muscles around, the rectus may be followed upwards to its origin from the pelvis. Cut through the band of fascia.

The QUADRICEPS EXTENSOR CRURIS consists of four parts or heads, one long or superficial (*rectus*), which springs from the pelvis, and three short or deep (*vastus internus*, *crureus*, and *vastus externus*) which arise from the femur: all are united below in a common tendon. Great extensor of knee.

The RECTUS FEMORIS (fig. 59, [13]) gives rise to a fleshy prominence on the front of the thigh. It *arises* from the pelvis by two tendinous heads; one, the anterior, is attached to the anterior inferior iliac spine; and the other, posterior, is fixed to a rough mark on the outer surface of the ilium close above the acetabulum (fig. 47, p. 113): near their origin they join to form a single tendon. The fleshy fibres terminate below in another tendon, which joins the aponeuroses of the other muscles in the common tendon. Rectus has double origin at pelvis; insertion into common tendon.

The rectus is larger in the middle than at the ends; and its fibres are directed from the centre to the sides, giving rise to the condition called penniform. Its upper end is covered by the tensor fasciæ The muscle is penniform, and superficial except above.

femoris, iliacus, and sartorius; but in the rest of its extent it is superficial. It conceals branches of the external circumflex artery and anterior crural nerve, and rests on the crureus and vasti. The upper tendon of the rectus reaches farthest on the anterior surface; while the lower tendon is most extensive on the posterior aspect of the muscle.

Cut the rectus, and display three deep heads of extensor:

Dissection. To see the remaining muscles, cut across the rectus near the lower end and raise it without injuring the branches of vessels and nerves beneath (fig. 59). The muscular mass covering the shaft of the femur is to be thoroughly cleaned, and its three parts defined in the following way:—

define vastus externus;

The division between the vastus externus on the outer side and the crureus in front is readily made in the situation of some vessels and nerves, which descend along the anterior border of the vastus externus.

separate crureus and vastus internus, beginning below,

To separate the vastus internus from the crureus, the lower end of the rectus must be turned down as far as possible, when a cleft will be evident in the subjacent tendon above the inner part of the patella. From this interval the division may be easily carried upwards between the two muscles, but at the upper end some fleshy fibres generally need cutting to complete the separation. If the vastus internus be turned inwards off the crureus, a large part of the inner surface of the femur will be seen to be free from muscular attachment.

and exposing bare surface of bone.

Vastus externus is thin at the origin;

The VASTUS EXTERNUS has a narrow attachment to the femur in comparison with its size (fig. 60, and fig. 61, p. 158). It takes *origin* from the upper half of the femur, by a piece from half an inch to an inch thick, which is attached to the root of the neck of the femur, and the fore and outer parts of the root of the great trochanter; then along the outer side of the gluteal ridge, and the upper half of the linea aspera; and lastly from the contiguous external intermuscular septum. Inferiorly most of the fibres of the muscle end in a flat tendon, which blends with those of the other portions in the common tendon, but the lowest fibres of all are inserted directly into the outer border of the patella.

ends in common tendon;

parts in contact with the surfaces.

The vastus externus is the largest part of the quadriceps, and produces the prominence on the outer side of the thigh. Its cutaneous surface is aponeurotic above, and is partly covered by the rectus, tensor vaginæ femoris, and gluteus maximus muscles. The deep surface rests on the crureus, and receives branches of the external circumflex artery and anterior crural nerve.

Vastus internus arises from femur and adductor tendons;

The VASTUS INTERNUS (figs. 58, E, p. 151) also has a narrow origin from the lower part of the anterior intertrochanteric line and from the inner surface of the femur (figs. 60 and 61) along the linea aspera, from the upper part of the internal supra-condylar ridge, and, in the lower half of the thigh, from the front of the tendons of the adductor longus and magnus. The fibres join an aponeurosis which blends in the common tendon, and is also attached directly to the inner margin of the patella reaching lower than the vastus externus.

The muscular mass is in part covered by the sartorius and rectus, but it projects between those muscles below. Some of the lower fibres are almost transverse, and will be able to draw the patella inwards. forms prominence above knee.

The CRUREUS arises from the upper three-fourths of the anterior and outer surfaces of the femur, except where they are occupied by Crureus has widest origin;

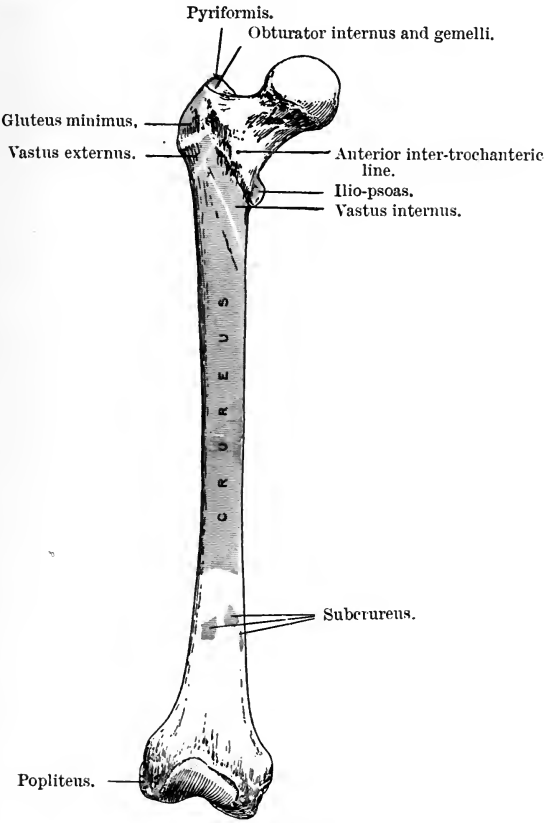


FIG. 60.—THE FEMUR FROM THE FRONT.

the vastus externus (figs. 60 and 61), and from the lower half of the external inter-muscular septum. Its fibres end, like the other parts, in an aponeurosis which enters into the common tendon. common ending:

The rectus and vasti cover the crureus except for a small extent at its lower and hinder part. It lies upon the bone and the sub-crureus muscle. is deepest part of all.

The *common* or *suprapatellar tendon* resulting from the union of the foregoing is attached to the fore part of the upper border of the patella. It is oblong in shape, and about three inches long. A few Common tendon above knee.

fibres are prolonged over the front of the bone into the ligamentum patellæ below, which forms the continuation of the tendon. Between the suprapatellar tendon and the femur there is a bursa, which usually opens into the knee-joint.

Sub-crureal bursa.

Lay bare part below knee.

Dissection. To see the continuation of the extensor tendon, and its insertion into the tibia, the student should divide along the middle

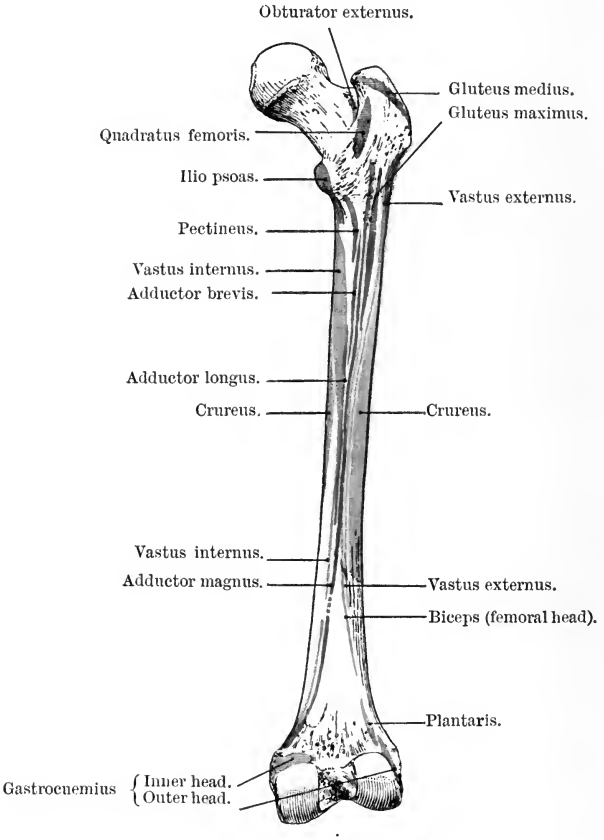


FIG. 61.—THE FEMUR FROM BEHIND.

line of the patella and knee-joint a thin aponeurotic layer, which is derived from the lower fibres of the muscles and covers the joint. On reflecting inwards and outwards the fibrous layer, the tendon will be exposed.

Infrapatellar tendon inserted into tubercle of tibia;

The *infrapatellar tendon*, or *ligamentum patellæ*, is about two inches long, and is narrower and thicker than the part above the knee. It extends from the lower margin of the patella to the tubercle of the tibia; and a bursa separates it from the bone above its insertion.

From the lower part of the vasti muscles a superficial aponeurotic expansion is derived: this prolongation, which is strongest on the inner side, is united with the fascia lata and the other tendinous offsets to form a capsule in front of the joint, and is fixed below to the heads of the tibia and fibula. expansion over it.

Subcrureus muscle. Beneath the crureus, near the knee-joint, is a thin layer of pale fibres, which is but a part of the large muscle, separated from the rest by areolar tissue. Attached to the femur in the lower fourth, and often by an outer and inner slip, it ends in aponeurotic fibres on the synovial sac of the knee-joint. Small subcrureus muscle ends on the synovial sac.

Action. All parts of the quadriceps extend the knee-joint when the tibia is moveable; and the rectus can flex the hip-joint over which it passes. The fleshy bellies are strong enough to break the patella transversely over the end of the femur, or to rupture sometimes the common tendon. Use with tibia moveable:

With the tibia as the fixed point the vasti will bring forwards the femur, and straighten the knee, as in rising from the stooping posture and in jumping. The rectus also will stay the pelvis on the femur, or assist in moving it forwards in stooping. with tibia fixed:

The subcrureus draws upwards the pouch of synovial membrane above the patella in extension of the knee. how subcrureus acts.

INTERMUSCULAR SEPTA. The processes of the fascia lata, which limit the extensor muscle laterally, are named external and internal, and are fixed to the linea aspera and the lines leading to the condyles of the femur. Intermuscular septa are two:

The *external septum* is the stronger, and reaches from the insertion of the gluteus maximus to the outer condyle of the femur. It is situate between the vastus externus and crureus on the one side, and the short head of the biceps on the other, to all of which it gives origin: it is perforated near the outer condyle by the upper external articular vessels and nerve. the outer is the stronger;

The *inner partition* is very thin along the side of the vastus internus; and its place is supplied by the strong tendon of the adductor magnus between the inner condyle and the linea aspera. the inner is indistinct.

The EXTERNAL CIRCUMFLEX ARTERY (fig. 59,[4], p. 153) is the chief vessel for the supply of the muscles of the front of the thigh. It usually arises from the outer side of the deep femoral artery, but often from the common trunk. It is directed outwards through the divisions of the anterior crural nerve, and beneath the sartorius and rectus muscles, and supplies offsets to those muscles. Its terminal branches are ascending, transverse, and descending:— External circumflex artery divides into

The *ascending branch* is directed beneath the tensor fasciæ femoris to the outer side of the hip, where it anastomoses with the gluteal artery, and supplies the contiguous muscles. ascending,

The *transverse branch*, the smallest, divides into two or three which enter the vastus externus, and anastomose with the perforating arteries. transverse,

The *descending branch* is the largest, and ends in pieces which are distributed to the crureus and vastus externus muscles. One considerable branch descends to the knee along the anterior border of and descending branches.

the vastus externus muscle in company with the nerve to the same, and anastomoses with the upper external articular artery ; a small offset courses over the muscle with a nerve to the joint.

Anterior crural nerve

The ANTERIOR CRURAL NERVE (fig. 59) derived from parts of the second, third and fourth lumbar nerves supplies the muscles, and most of the integuments of the front of the thigh, and the integuments of the inner side of the leg. Soon after the trunk of the nerve leaves the abdomen and enters the thigh immediately external to the common femoral artery it is flattened, and is divided into superficial and deep divisions.

divides into two parts.

From its superficial part arise—

A. The SUPERFICIAL DIVISION gives off the middle and internal cutaneous nerves, and branches to the sartorius and pectineus muscles.

middle cutaneous ;

The *middle cutaneous nerve* perforates the fascia lata, sometimes also the sartorius, about three inches below Poupart's ligament, and extends to the knee (p. 141).

internal cutaneous,

The *internal cutaneous nerve* sends two or more small twigs through the fascia lata to the integument of the upper two-thirds of the thigh, and then divides in front of the femoral artery, or on the inner side, into anterior and posterior branches. Sometimes these branches arise separately from the anterior crural trunk.

which has anterior and

The *anterior branch* is directed to the inner side of the knee. As far as the middle of the thigh it lies over the sartorius, but it then pierces the fascia lata, and ramifies in the integuments (p. 141).

posterior branches ;

The *posterior branch* remains beneath the fascia lata as far as the knee. While underneath the fascia the nerve lies along the inner border of the sartorius, and joins in a plexus, about the middle of the thigh, with offsets of the obturator, and nearer the knee, with a branch of the internal saphenous nerve.

nerve to pectineus ;

The *nerve to the pectineus* (fig. 57, [2], p. 147) is slender, and is directed inwards beneath the femoral vessels to the anterior surface of the muscle : sometimes there are two branches.

branches to sartorius.

Two or three *branches to the sartorius* arise in common with the middle cutaneous nerve.

The deep part gives off branches

B. The DEEP DIVISION of the anterior crural nerve furnishes branches to the several heads of the quadriceps extensor muscle, and one cutaneous nerve—the long, or internal, saphenous.

to rectus,

The *branch to the rectus* enters the deep surface of the muscle ; from this branch a twig is sent to the hip-joint.

to vastus externus,

The *nerve to the vastus externus* divides into two or more parts as it enters the muscle. From one of these an *articular* filament is often continued downwards to the knee-joint.

to crureus,

Two or three *branches to the crureus* pass into the anterior surface of the muscle ; and from the most internal a long twig descends to the subcrureus and the knee-joint.

and to vastus internus :

The *nerve to the vastus internus* (fig. 62, [8], p. 165) is nearly as large as the internal saphenous, in common with which it often arises. To the upper end of the vastus it furnishes one or more branches, and is then continued as far as the middle of the thigh, where it ends in offsets to the muscle and the knee-joint.

Its *articular branch* (fig. 62, [9]) is prolonged on or in the vastus, and on the tendon of the adductor magnus, to the inner side of the knee-joint, where it is distributed over the synovial membrane of the articulation. This small nerve accompanies the deep branch of the anastomotic artery.

The *internal* or *long saphenous nerve* (fig. 59, p. 153) is the largest branch of the anterior crural. In the thigh the nerve takes the course of the deep blood-vessels, and is continued along the artery, beneath the aponeurosis covering the same, as far as the opening in the adductor magnus muscle. At that spot the nerve passes from beneath the aponeurosis, and is prolonged under the sartorius muscle to the upper part of the leg, where it becomes cutaneous. It supplies two offsets while it is beneath the fascia in the thigh. and long saphenous nerve,

A *communicating branch* arises about the middle of the thigh, and crosses inwards beneath the sartorius to join in the plexus of the internal cutaneous and obturator nerves, or with the internal cutaneous nearer the knee: this branch is often absent. which has a communicating

The *patellar branch* springs from the nerve near the knee-joint, and perforating the sartorius muscle and the fascia lata, ends in the integument over the knee (p. 141). and a patellar offset.

A branch of the superior gluteal nerve (p. 117) to the deep surface of the tensor fasciæ femoris may be followed at this stage nearly to the lower end of the muscle. Nerve of tensor fasciæ femoris.

Directions. After the examination of the muscles of the front of the thigh, with their vessels and nerves, the student is to learn the adductor muscles, and the vessels and nerves which belong to them. Take next the adductors.

Section II.

THE INNER SIDE OF THE THIGH.

The muscles in this position are the three adductors,—longus, brevis, and magnus, with the gracilis and pectineus. These have the following position with respect to one another:—Internal to all, and the longest, is the gracilis. Superficial to the others are the pectineus and the adductor longus; and beneath the last two are the short adductor and the adductor magnus. The adductor muscles and their position.

In connection with these muscles, and supplying them, are the profunda femoris artery with the accompanying vein, and the obturator nerve. Vessels and nerve.

Dissection. For the preparation of the muscles, the investing fascia and tissue are to be taken away; and the two superficial adductors are to be separated from one another. Let the student be careful of the branches of the obturator nerve in connection with the muscles, viz., those entering the fleshy fibres, and one issuing beneath the adductor longus, to join the plexus at the inner side of the thigh. Lastly, should any fat and veins be left with the profunda artery and its branches, they must be removed. Dissection of adductor muscles. Nerves. Remove veins.

The GRACILIS reaches from the pelvis to the tibia (fig. 62, c, p. 165), and is fleshy and riband-like above, but tendinous below. The Gracilis takes origin from the pelvis;

muscle *arises* by a thin aponeurosis, two or three inches in depth, from the pubic border of the hip-bone close to the margin, viz., opposite the lower half of the symphysis, and the upper part of the pubic arch (fig. 47, p. 113). Inferiorly it is *inserted* by a flat tendon, about one-third of an inch wide, into the inner surface of the tibia, beneath and close to the sartorius (fig. 68, p. 179).

is inserted into tibia;

position to other muscles;

The muscle is superficial throughout. For two-thirds of the thigh it is flattened against the adductors brevis and magnus, so as to have its borders directed forwards and backwards; and in the lower third it intervenes between the sartorius and semimembranosus muscles, and helps to form the inner boundary of the popliteal space. At its insertion the tendon is nearer the knee than that of the semitendinosus, though at the same depth from the surface, and both lie over the internal lateral ligament; from the tendon an expansion is continued to the fascia of the leg, like the sartorius. A bursa separates the tendon from the internal lateral ligament, and projects above it under the sartorius.

use on knee-joint and femur;

Action. It bends the knee-joint if the tibia is not fixed, rotating inwards that bone, and then brings the movable femur towards the middle line with the other adductors.

on pelvis.

Supposing the foot resting on the ground, the gracilis will aid in staying the pelvis on the limb.

Pectineus: origin from pubis;

The PECTINEUS (fig. 58, F, p. 151) is the highest of the muscles directed from the pelvis to the inner side of the femur. It has a fleshy *origin* from the pubic portion of the ilio-pectineal line, and slightly from the surface in front of that line (fig. 47); and it is *inserted* by a thin tendon, about two inches in width, into the femur behind the small trochanter, and into the upper part of the line which extends from that process to the linea aspera (fig. 61, p. 158).

inserted into femur;

relations of surfaces,

One surface of the muscle is in contact with the fascia lata; and the femoral vessels lie over its lower part: the opposite surface touches the obturator externus and adductor brevis muscles, and the superficial portion of the obturator nerve. The pectineus lies between the psoas and the adductor longus; and the internal circumflex vessels pass between its outer border and the psoas.

and borders;

use on femur, free and fixed.

Action. It adducts the limb and bends the hip-joint. When the femur is fixed it can support the pelvis in standing; or it can draw forwards the pelvis in stooping.

Adductor longus extends from pelvis to femur;

The ADDUCTOR LONGUS lies below the pectineus (fig. 58, G), and is triangular in form, with the apex at the pelvis and the base at the femur. It *arises* by a narrow tendon from the front of the pubis in the angle between the crest and the symphysis (fig. 47); and it is *inserted* into the inner edge of the linea aspera, blending with the insertion of the subjacent adductors (fig. 61).

relations to muscles and vessels;

This muscle is situate between the gracilis and the pectineus, and forms part of the floor of Scarpa's triangle. Its anterior surface is covered near the femur by the femoral vessels and the sartorius; the posterior rests on the other two adductors, on the superficial part of the obturator nerve, and on the deep femoral artery. The

tendon of insertion is closely united to the adductor magnus and vastus internus.

Action. With the femur movable, it will flex the hip-joint, and with the aid of the other adductors will carry inwards the limb, so as to cross the thigh-bones. In walking it helps the other adductors to project the limb. use on femur,

With the femur fixed, the muscle holds and tilts forwards the pelvis. on pelvis.

Dissection. The adductor brevis muscle, with the obturator nerve and the profunda vessels, will be arrived at by reflecting the two last muscles (fig. 62, p. 165). On cutting through the pectineus near the pubis and throwing it down, the dissector may find occasionally the small accessory nerve of the obturator, which turns beneath the outer border ; if this is present, its branches to the hip-joint and the obturator nerve are to be traced out. The adductor longus is then to be divided near its origin, and raised with care, so as not to destroy the branches of the obturator nerve beneath : its tendon of insertion also is to be detached from that of the adductor magnus beneath it, to see the branches of the profunda artery. Dissection of accessory obturator nerve cut adductor longus

Now the adductor brevis will be laid bare. A part of the obturator nerve crosses over this muscle to the femoral artery, and sends an offset to the plexus at the inner side of the thigh ; and a deeper part of the same nerve lies beneath the muscle. The muscle should be separated from the subjacent adductor magnus, whereon the deep branch of the nerve lies. In this last step of the dissection, the student should follow the slender articular branch of the obturator nerve through the fibres of the adductor magnus (p. 130). to show adductor brevis ; trace obturator nerve, and branch to knee-joint.

The *accessory obturator nerve* (Schmidt) is derived from the trunk of the obturator, near its origin, and passes from the abdomen over the brim of the pelvis. In the thigh it turns beneath the pectineus, and joins the superficial branch of the obturator nerve ; it supplies an offset to the hip-joint with the articular artery, and occasionally one to the under-surface of the pectineus. Accessory obturator nerve.

The ADDUCTOR BREVIS (fig. 62, D) has a fleshy and tendinous *origin*, about one inch and a half in depth, from the front of the pubis below the adductor longus, and close outside the gracilis (fig. 47). It is *inserted*, behind the pectineus, into all the line leading from the linea aspera to the small trochanter (fig. 61). Adductor brevis is narrow at origin, and wide at insertion.

In front of the muscle are the pectineus and the adductor longus, with the superficial part of the obturator nerve, and the profunda artery ; but it is gradually uncovered by the adductor longus below, and the contiguous parts of the muscles are blended at their insertion into the femur. Behind the muscle is the adductor magnus, with the deep piece of the obturator nerve and a branch of the internal circumflex artery. In contact with the upper border lies the obturator externus (F), and the internal circumflex artery passes between the two. Parts in front, behind, and at upper border.

Action. This muscle adducts the limb with slight flexion of the hip-joint, like the pectineus. And if it acts from the femur, it will balance and move forwards the pelvis. Use, femur free, and fixed.

Obturator nerve

The OBTURATOR NERVE (fig. 62,[1]) is derived from portions of the second, third, and fourth lumbar nerves, and supplies the adductor muscles of the thigh, as well as the hip and knee-joints. The nerve issues from the pelvis through the aperture in the upper part of the thyroid foramen; and it divides in that opening into two parts, which are named superficial and deep, from their position with respect to the adductor brevis muscle.

is divided into two.

The superficial part ends on femoral artery, and joins plexus in the thigh;

A. The *superficial part* ([2]) of the nerve is directed over the adductor brevis, but beneath the pectineus and the adductor longus, to the femoral artery, on which it is distributed: at the lower border of the last muscle it furnishes an offset or two, joining in a plexus with the internal cutaneous and saphenous nerves (p. 141), and often helping to supply the integuments.*

branches are to hip-joint,

In the aperture of exit, this piece of the nerve sends outwards an *articular* twig to the hip-joint.

muscular to adductors.

Muscular branches from this superficial part are furnished to the pectineus (sometimes), adductors longus and brevis, and the gracilis.

Deep part of the nerve

B. The *deep part* ([4]) of the obturator nerve pierces the fibres of the external obturator muscle, and, continuing beneath the adductor brevis, is consumed chiefly in the adductor magnus. The following offsets are supplied by it:—

ends in adductor magnus

Muscular branches enter the obturator externus as the nerve pierces it; others are furnished to the large, and sometimes to the short adductor.

and gives branch to knee-joint.

A slender *articular branch* (fig. 62,[5]) enters the fibres of the adductor magnus, and passes through this near the linea aspera to reach the popliteal artery, by which it has been seen that it is conducted to the back of the knee-joint.

Dissect profunda.

Dissection. To prepare the profunda artery and its branches, as far as they are to be seen on the front of the thigh, it will be requisite to follow back the internal circumflex artery above the upper border of the adductor brevis, and to trace the perforating branches to the apertures in the adductors near the femur.

Profunda artery:

origin,

course,

and ending;

The DEEP FEMORAL (fig. 62, *c*) is the chief muscular artery of the thigh, and arises from the common femoral about an inch and a half below Poupart's ligament. At its origin the vessel is placed on the outer side of the parent trunk; but it is soon directed inwards beneath the superficial femoral vessels to the inner side of the femur, and ends at the lower third of the thigh in a small branch that pierces the adductor magnus.

parts around.

In Scarpa's triangle the vessel lies at first on the iliacus muscle. On the inner side of the femur it is parallel to the superficial femoral artery, though deeper in position; and it is placed first over the pectineus and adductor brevis, and thence to its termination between the adductus longus and magnus.

* In some bodies the superficial part of the nerve is of large size and has a distribution similar to that of the inner branch of the internal cutaneous nerve, the place of which it takes: in such instances it joins freely in the plexus.

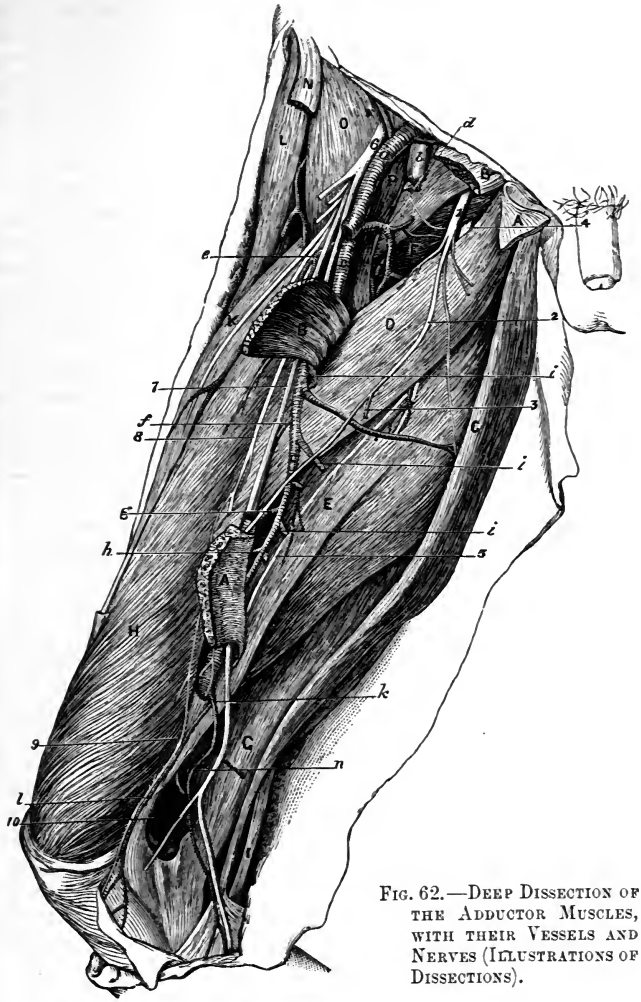


FIG. 62.—DEEP DISSECTION OF THE ADDUCTOR MUSCLES, WITH THEIR VESSELS AND NERVES (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Adductor longus, cut.
B. Pectineus, cut.
C. Gracilis.
D. Adductor brevis.
E. Adductor magnus.
F. Obdurator externus.
G. Semimembranosus.
H. Vastus internus.
K. Rectus femoris.
L. Tensor fasciæ latæ.
N. Piece of the sartorius.
O. Iliacus.
P. Psoas.

Vessels:

a. Femoral artery, and *b*. Femoral vein.
c. Trunk of the profunda.
d. Internal, and *e*, external circumflex.
f. First, *g*, second, and *h*, third perforating.
i. Muscular of the profunda.
k. Anastomotic of the femoral, with *l*, its deep, and *n*, its superficial branch.

Nerves:

1. Obturator, joined by the accessory obturator nerve, with 2, the superficial, and 4, the deep part.
3. Cutaneous branch of the obturator.
5. Articular branch to the knee from the deep part.
6. Anterior crural nerve.
7. Internal saphenous, and 10, its patellar branch.
8. Nerve to the vastus internus, and 9, its articular branch to the knee.

Branches to muscles of the thigh join freely.

Its BRANCHES are numerous to the surrounding muscles on the front and back of the thigh, and maintain free anastomoses with other vessels of the thigh; through these communications the blood finds its way to the lower part of the limb when the chief artery is obliterated either above or below the origin of the profunda. The named *branches* are these :—

External circumflex.

1. The *external circumflex artery* (fig. 62, *e*) has been described in the dissection of the parts on the front of the thigh (p. 159).

Internal circumflex

2. The *internal circumflex artery* (fig. 62, *d*) arises from the inner and posterior part of the profunda, and turns backwards between the psoas and pectineus, but above the adductor brevis. Opposite

ends on back of thigh;

the small trochanter it ends in *ascending* and *transverse* branches, which have been seen in the dissection of the buttock (p. 123). It also supplies offsets on the inner side of the thigh, viz. :—

supplies hip-joint and muscles.

An *articular artery* which enters the hip-joint through the notch in the acetabulum; and two *muscular branches* at the border of the adductor brevis ;—one ascends to the obturator and the superficial adductor muscles: the other, which is larger, descends with the deep division of the obturator nerve beneath the adductor brevis, and ends in this and the largest adductor.

Three perforating branches:

3. The *perforating arteries*, three in number, pierce the tendons of some of the adductor muscles close to the linea aspera of the femur: they supply muscles on the back of the thigh, and wind round the bone to end in the vastus externus and crureus (p. 133).

first;

The *first* (fig. 62, *f*) begins opposite the lower border of the pectineus, and perforates the short and great adductors.

second;

The *second* (*g*) arises below the middle of the adductor brevis, and passes through the same muscles as the preceding.

third

The *third* (*h*) springs from the deep femoral trunk below the adductor brevis, and is transmitted through the adductor magnus. From the second or third perforating vessel a *medullary artery* is supplied to the femur.

and the ending is a fourth.

The *terminal* branch of the profunda (fourth perforating) pierces the adductor magnus near the aperture for the femoral artery.

Anastomotic branches.

4. *Muscular* or *anastomotic branches* (*i*) to the back of the thigh (three or four in number) pass through the adductor magnus at some distance from the linea aspera, and end in a chain of anastomoses in the hamstrings (p. 134).

Profunda vein.

The PROFUNDA VEIN results from the union of the different branches corresponding with the offsets of its companion artery. It accompanies closely the artery of the same name, to which it is superficial, and ends above in the common femoral vein.

Cut through adductor brevis.

Dissection. To bring into view the remaining muscles, viz., adductor magnus, obturator externus, and the insertion of the psoas and iliacus, the adductor brevis is to be cut through near the pelvis, and thrown down. Then the investing layer of fascia and areolar tissue is to be removed from each muscle.

After the adductor magnus has been learnt, detach a few of its upper fibres to examine the obturator externus.

The ADDUCTOR MAGNUS (fig. 62, E) is triangular in form, with its base directed upwards, one side being attached to the femur, and the other free at the inner side of the thigh. Adductor magnus :

The muscle arises from the conjoined rami of the pubis and ischium along their inner margin, and from the lower impression on the ischial tuberosity (fig. 47, p. 113). The anterior fibres diverge from their origin, being horizontal above but more oblique below, and are *inserted* into the back of the femur, from above downwards, along the inner side of the gluteal ridge, into the linea aspera, and into the internal supracondylar line for about an inch (fig. 61, p. 158). The posterior fibres, from the ischial tuberosity, are vertical in direction, and end at the lower third of the thigh in a tendon, which is inserted into the inner condyle of the femur, surrounding the adductor tubercle, and is connected by a fibrous expansion to the lower part of the internal supracondylar line. origin is narrow; fibres diverge to their insertion, some being horizontal, others vertical,

The muscle consists of two parts, which differ in their characters. The anterior (*pubic*), thin and fleshy, forms a septum between the other adductors and the muscles on the back of the thigh ; but the posterior (*ischial*) piece, partly fleshy and partly tendinous, constitutes the inner thick margin of the muscle. On the anterior surface are the other two adductors and the pectineus, with the obturator nerve and the profunda vessels. The posterior surface touches the hamstring muscles and the great sciatic nerve. In contact with the upper border are the obturator externus and the quadratus femoris, with the transverse branch of the internal circumflex vessels ; and along the inner border lie the gracilis and the sartorius. At its attachment to the femur the muscle is closely united with the other adductors, particularly the adductor longus, and in its lowest part with the vastus internus. Near the bone it is pierced by apertures for the passage of the femoral and perforating arteries. and form two parts. Relations of surfaces, and borders.

Action. This muscle is a powerful adductor ; and the part arising from the tuberosity is also an extensor of the hip. In standing, the latter part of the muscle, acting from the femur, has an important influence in steadying the hip-joint ; and in walking, the great and other adductors co-operate with the gluteal muscles externally, to support the pelvis on the fixed limb. Use on femur; in standing; in walking.

The *opening* in the adductor for the transmission of the superficial femoral vessels into the popliteal space is tendinous at the anterior, but fleshy at the posterior aspect. It is situate at the junction of the upper three-fourths with the lowest fourth of the thigh, and is larger than is necessary for the passage of the vessels. On the outside it is bounded by the vastus internus ; and on the inside by the tendon of the adductor magnus, with some fibres added from the tendon of the long adductor. Opening for the vessels: boundaries.

The PSOAS and ILIACUS (fig. 62) arise separately in the abdomen, but are united in the thigh, the conjoined portion of the muscles lying beneath Poupart's ligament. The psoas (P) is *inserted* by tendon into the small trochanter of the femur ; and the fleshy iliacus (O) mainly joins the tendon of the psoas, but a few of its Psoas and iliacus in the thigh: insertion into femur;

fibres are fixed into a special triangular surface of bone in front of and below the trochanter (fig. 61).

parts around;

These muscles occupy the interval beneath Poupart's ligament between the ilio-pectineal eminence and the anterior superior iliac spinous process; and below the pelvis the mass covers the capsule of the hip-joint, a large bursa intervening. On the front of the psoas is the common femoral artery, and between the two muscles lies the anterior crural nerve. The pectineus and the internal circumflex vessels are contiguous to the inner border, and the sartorius and vastus internus touch the outer edge.

use.

Action. These muscles act as flexors of the hip-joint; and the use of the psoas on the spinal column will be given with the description of the muscle in the abdomen.

Obturator externus

origin;

The OBTURATOR EXTERNUS (fig. 62, F) is triangular in form, with the base at the pelvis and the apex at the femur. The fibres of the muscle take *origin* from the outer surface of the obturator membrane for the inner half, and from the bony circumference of the thyroid foramen for a corresponding extent,—the bony attachment being an inch wide opposite the body of the pubis, and reaching inwards to the adductor brevis and magnus (fig. 47, p. 113). The

insertion.

fibres are directed backwards and outwards to be *inserted* by a tendon into the pit at the root of the great trochanter.

The adductors cover it;

This muscle is concealed by the pectineus, and adductor brevis and magnus. It covers the obturator membrane and vessels, and is pierced by the deep part of the obturator nerve. As it winds

and it touches hip-joint.

back it is in contact with the lower surface of the hip-joint. The insertion of the muscle has been seen in the dissection of the buttock (p. 123).

Use.

Action. The muscle is an external rotator of the thigh, and to a slight extent an adductor and flexor of the hip-joint.

Detach obturator.

Dissection. By detaching the obturator muscle from the pelvis, the branches of the artery of the same name will be seen beneath its fibres. The deep part of the nerve may be followed back to the foramen at the same time. A better view will be obtained if this dissection is deferred till after the limb is removed.

Obturator artery

divides into two:

The OBTURATOR ARTERY is a branch of the internal iliac within the pelvis, and enters the thigh through the top of the thyroid foramen. In the aperture the artery divides into two branches, which form a circle on the obturator membrane beneath the muscle:—

inner,

The *internal branch* runs along the inner half of the membrane, and furnishes offsets to the obturator externus and the upper ends of the adductor muscles.

and outer branch.

The *external branch* descends close to the outer edge of the foramen, and after giving a branch inwards to join the lower end of the preceding, is continued to the ischial tuberosity and the muscles arising therefrom. Offsets pass to both obturator muscles; and an *articular* twig is given to the hip-joint.

Branches of the nerve.

The *nerves to the obturator externus* come from the deep portion of the obturator, and enter the posterior surface of the muscle.

Section III.

THE HIP-JOINT.

Dissection. The capsule of the hip-joint should now be cleaned. Cut through the iliacus and psoas below Poupart's ligament, and turn them down. In doing so a large bursa will be opened which facilitates the movement of these muscles over the front of the joint. Sometimes it will be found that this bursa communicates with the joint cavity through a thin part in the front of the capsule (fig. 63). The rectus femoris, the sartorius, the tensor fasciæ femoris, and the gluteus minimus should be cleared from the joint, and the front, outer, and inner parts of the capsule cleaned, as has already been done at the back. The intimate connection of the reflected

Bursa under ilio-psoas.

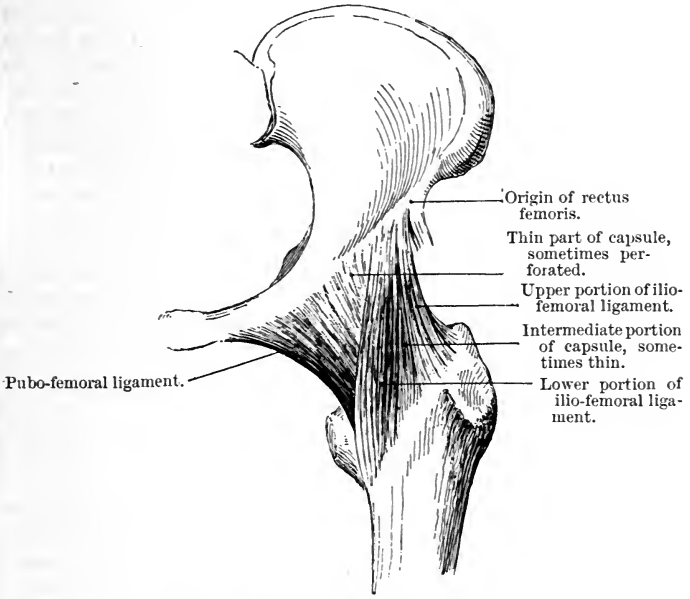

Origin of rectus femoris.
Thin part of capsule, sometimes perforated.
Upper portion of ilio-femoral ligament.
Intermediate portion of capsule, sometimes thin.
Lower portion of ilio-femoral ligament.
Pubo-femoral ligament.

Fig. 63.—Anterior Aspect of Hip-joint.

head of the rectus and of the insertion of the gluteus minimus with the adjacent part of the capsule will be noticed.

The Hip-joint. This articulation is a ball and socket joint, the head of the femur being received into the acetabulum of the hip-bone. Connecting the bones are the following ligaments:—one to deepen the receiving cavity, which is named *cotyloid;* another between the articular surfaces of the bones—the *interarticular;* and a *capsule* around all.

Hip-joint, how formed; its ligaments.

In the capsule itself the student has to define a wide thick part in front, and a transverse band near the neck of the femur behind.

Define its fibres.

Capsule: attachments above and below; thickness varies.

The *capsular ligament* (fig. 63) is a thick fibrous case, which encloses the head and the greater part of the neck of the femur. Its upper margin is attached to the circumference of the acetabulum close to the edge, as well as to a transverse ligamentous band over the notch at the lower part of the cavity. Its lower margin is inserted *in front* into the anterior intertrochanteric line; *behind*, by a very thin piece, into the neck of the femur about a finger's breadth from the small trochanter and the posterior intertrochanteric line (fig. 64); and *above*, into the neck near the great trochanter. The capsule differs much in strength and in the arrangement of the fibres at the fore and hinder parts.

Ilio-femoral ligament: attachments; division; and use.

On the front it is strengthened by a broad and thick layer of longitudinal fibres—the *ilio-femoral ligament* (fig. 63). This is fixed above, where it is about an inch broad, to the lower part of the anterior inferior iliac spine and to a rough mark continued backwards therefrom on the outer surface of the ilium immediately above the acetabulum below the reflected head of rectus muscle. Becoming wider below, it is inserted into the whole length of the anterior intertrochanteric line; and its fibres generally form two stronger bands (fig. 63), which are attached at the upper and lower ends respectively of the intertrochanteric line, with a thinner part in the middle. From this arrangement the name of the Y-shaped ligament has also been given to it. From its position, the ilio-femoral ligament will arrest extension of the joint; and when the femur is fixed in standing it will support the pelvis.

Pubo-femoral band.

At the inner and fore part of the joint is a much smaller band, which extends from the prominent portion of the pubis internal to the acetabulum to the lower end of the anterior intertrochanteric line, and is named the *pubo-femoral ligament* (fig. 63).

Thin part of capsule.

Between the ilio-femoral and pubo-femoral ligaments, near the hip-bone, the capsule is thin, and sometimes presents an opening, through which the bursa under the ilio-psoas communicates with the joint-cavity.

Circular band at back of capsule: use.

At the back of the capsule is a band of transverse fibres (*zonular band*) (fig. 64, *b*), about half an inch wide, which arches like a collar over the neck of the femur. By its lower edge it is united to the bone by a thin layer (*c*) of fibrous tissue and synovial membrane; at the upper edge it is joined by the longitudinal capsular fibres (*a*). It gives insertion to the longitudinal fibres of the capsule, and prevents that restriction of the swinging movement which would result from their insertion into the hinder part of the neck.

At the lower part of the capsule is another thickening (the *ischio-capsular* band), which passes from the ischium below the acetabulum into the lower and back part of the capsule.

Muscles around.

Posteriorly the joint is covered by the obturator internus and gemelli muscles, and anteriorly by the rectus femoris and ilio-psoas. Above is the gluteus minimus, the tendon of which is united to the capsule; and below is the obturator externus.

Dissection (fig. 65, p. 173). The capsular ligament is now to be divided over the prominence of the head of the femur, and this bone being disarticulated but not detached, the cotyloid and interarticular ligaments inside it will appear. The interarticular or round ligament is attached to the acetabulum by two pieces; and to bring these into view, the synovial membrane and areolar tissue must be removed. The transverse ligament over the notch is also to be defined.

Cut open the capsule.

Define round ligament.

The *cotyloid ligament* is a narrow band of fibro-cartilage, which is fixed to the margin of the acetabulum, and is prolonged across the notch below, so as to form part of the transverse ligament. Its fibres are not continued around the acetabulum, but are fixed to the margin of the cavity, and cross one another in the band. It is

Cotyloid ligament attached round acetabulum;

FIG. 64.—HINDER PART OF THE CAPSULE OF THE HIP-JOINT.

a. Longitudinal fibres.
b. Zonular band.
c. Thin piece attached to the neck of the femur about half-way down.

thickest at its attachment to the bone, and becomes gradually thinner towards the free margin, where it is applied to the head of the femur.

This ligament fills up the hollows in the rim of the acetabulum, deepens the socket for the femur, and makes a flexible margin to the cavity, which can yield slightly when the neck of the femur is pressed against it.

use.

The *transverse ligament* bridges across the notch in the lower and inner part of the margin of the acetabulum. It consists partly of deep special fibres which are attached to the margins of the notch, and partly of a superficial bundle from the cotyloid ligament Beneath it is an aperture by which vessels and nerves

Transverse ligament.

enter the acetabulum to supply the synovial membrane and the fat in the bottom of that hollow.

Round ligament: shape and

The *interarticular ligament* (ligamentum teres, fig. 65, *b*) is a band about an inch long, but of very variable thickness, which connects the head of the femur with the hip-bone. The ligament has a triangular form, the apex of the triangle being fixed to the pit on the head of the femur, and the base joining the transverse ligament. The free sides of the triangle are formed by two fibrous

attachments;

bundles, an anterior or pubic (*c*), which is attached with the transverse ligament to the pubic edge of the cotyloid notch, and a posterior or ischial (*d*), which is stronger, and is inserted beneath the transverse ligament into the ischial border of the notch.

how to see its action;

To see the condition of the interarticular ligament in the different movements of the joint, it should be examined in a specimen in which the capsule is entire, and the floor of the acetabulum has been cut out with a chisel from inside the pelvis.

loose in extension;

During extension of the joint the ligament is relaxed; and it cannot be tightened so long as the fully extended position is maintained.

tight in flexion with adduction or rotation outwards.

In flexion of the joint the ligament is rendered somewhat tighter; but it is only fully stretched when, with the joint bent, the femur is adducted or rotated outwards: the pubic fasciculus of the band is especially tightened by the adduction, and the ischial slip by the outward rotation.

Synovial membrane.

A *synovial membrane* lines the capsular ligament, and is continued along the neck of the femur to the margin of the articular surface. In the bottom of the cotyloid cavity it is reflected over the fat in that situation; and it surrounds the ligamentum teres.

Detach the limb.

Dissection. To see the surface of the acetabulum, the lower limb is to be separated from the trunk by dividing the interarticular ligament, and by cutting through any parts that connect it to the pelvis, and at this stage the pelvic attachments of the interarticular ligament can be better displayed.

Articular surface of femur.

Surfaces of bone. The articular surfaces of the bones are not completely covered with cartilage.

In the head of the femur is a pit into which the round ligament is inserted.

Acetabulum cartilaginous externally.

The acetabulum is coated with cartilage at its circumference, except opposite the cotyloid notch, and touches the head of the femur by this part: this articular surface is deep above, but gradually decreases towards the edges of the notch.

Fat in the bottom.

In the hollow of the cartilage, and close to the notch, is a mass of fat, covering about one-third of the area of the cotyloid cavity, which constitutes the "gland of Havers": it communicates with the fat of the thigh beneath the transverse ligament.

Kinds of motion.

Movements. In this ball and socket joint, there are the same kinds of movement as in the shoulder, viz., flexion and extension, abduction and adduction, circumduction and rotation, but all of them, with the exception of flexion, are of a much more limited extent.

Flexion and extension. In the swinging movement flexion is freer than extension, the thigh being capable of such elevation as to touch the belly. Swinging movement:

While swinging, the head of the femur revolves in the bottom of the acetabulum, rotating around a horizontal axis; and the rapidity and extent of the movements do not endanger the security of the joint, the head of the bone not having any tendency to escape. motion of head of femur;

In extension the strong ilio-femoral ligament (the inner band especially) is tightened, and stops the movement. Flexion is not checks to movement.

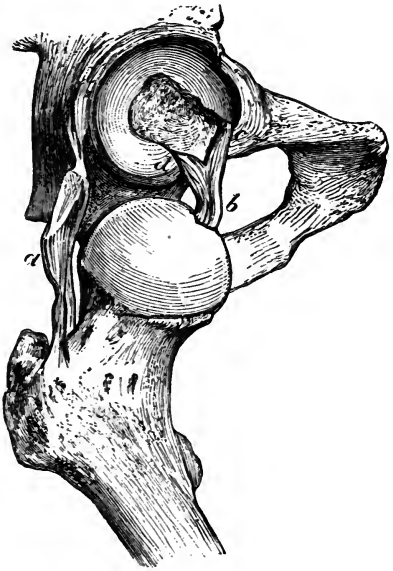


FIG. 65.—HIP-JOINT OPENED.

a. Part of the capsule.
b. Interarticular ligament: *c*, its pubic, and *d*, its ischial attachment.

naturally arrested by the ligaments of the joint, but by the meeting of the soft parts of the thigh and abdomen.

In *abduction* and *adduction* the femur is removed from, or brought towards, the middle line of the body, and, of the two, abduction is the more extensive. Lateral movement:

In both states the head moves in the opposite direction to the shaft. Thus, as the femur is abducted, the head descends, and a great part of the articular surface projects below the acetabulum; and when the limb is raised to its utmost, the upper edge of the neck meets the edge of the socket, so as to prevent further motion. As the limb descends and approaches the other, the head rises in motion of the head;

the socket of the joint, and is securely lodged, finally, in the deepest part of the cavity.

state of the ligaments.

In abduction, the pubo-femoral ligament and lower part of the capsule are tightened over the projecting head of the femur, the upper part being relaxed. And in adduction, the outer band of the ilio-femoral ligament is rendered tense and arrests the movement.

Dislocation in lateral movements.

Dislocation may take place in both these lateral movements, the edge of the cotyloid cavity serving as the fulcrum, on which the femur can be lifted out of the hollow, and particularly in abduction with some flexion, for there the head of the femur is against the thin under-part of the capsule.

Circumduction.

In *circumduction*, the four kinds of angular motion above noticed take place in succession, viz., flexion, abduction, extension, and adduction ; and the limb describes a cone, the base of which is at the foot, and the apex at the centre of the head of the femur. This movement is less free than in the shoulder-joint.

Rotation :

There are two kinds of *rotation*, internal and external ; in the former, the great toe is turned in ; and in the latter it is moved outwards.

inwards,

In rotation inwards, the head of the femur glides backwards horizontally across the acetabulum, the great trochanter coming forwards ; and the shaft of the bone revolves around a line internal to it, which passes from the centre of the head to the inner condyle. During this movement the posterior half of the capsule is put on the stretch, and the anterior is relaxed.

and outwards.

In rotation outwards, the head of the bone turns forwards in the cotyloid cavity, and the great trochanter is brought backwards. The outer band of the ilio-femoral ligament is tightened and checks the movement.

Examine attachment of muscles.

Dissection. After the limb is removed, the attachments of all the muscles in the thigh are again to be examined carefully before the dissection of the leg is undertaken. The muscles should not be removed from the femur, but about two inches of each left attached to the bone.

Section IV.

THE FRONT OF THE LEG.

Surface marking.

Directions. Before the dissection of the leg is begun, the student should make himself acquainted, as in the thigh, with the prominences of bone and muscle on the surface, and with the markings which indicate the position of the larger vessels.

In the leg the tibia is superficial,

Prominences of bone. The bones of the leg can be traced beneath the skin from the knee to the ankle-joint. At the inner and fore part is the tibia, which is subcutaneous in all its extent, and is limited in front and behind by a sharp edge. Above, it presents in front a prominent tubercle into which the ligament of the

patella is inserted; and on each side of this the tuberosities of the bone are superficial. The internal tuberosity is a uniform rounded prominence; but the external forms a marked projection at the outer and fore part of the knee. Below, the tibia ends on the inner side of the ankle in the internal malleolar projection. On the outer side of the leg the lower half of the fibula may be felt with ease, but the upper half with more difficulty in consequence of the prominence of the muscles of the calf. The head of this bone may be recognised below the knee; and the lower end forms the malleolus on the outer side of the ankle-joint.

and the fibula in part.

At the sides of the ankle are the prominent malleoli, the external being nearer to the heel; and when the joint is extended, the head of the astragalus can be felt below the tibia.

Ankle-joint.

Muscles and vessels of the leg. On the back of the leg is the swell of the calf: this is formed by the gastrocnemius and soleus muscles, and therefrom descends the firm band of the tendo Achillis, by which those muscles are connected with the heel. Between the tendon and the edge of the tibia, but nearer the former, is placed the superficial part of the posterior tibial artery. In front, between the tibia and fibula are the flexor muscles of the ankle and the extensors of the toes, amongst which the anterior tibial artery lies deeply, and the position of the vessel is indicated by a line from a point midway between the head of the fibula and the projection of the external tuberosity of the tibia to the centre of the ankle-joint.

Behind are calf of the leg, and tendo Achillis. Posterior tibial vessels. Line of anterior tibial artery.

Prominences of the foot. At the inner border of the foot, about an inch and a half in front of the internal malleolus, is the tuberosity of the navicular bone; while one inch and a half further forwards is a slight depression marking the articulation between the internal cuneiform and the metatarsal bone of the great toe. About the centre of the outer border of the foot is the tuberosity of the fifth metatarsal bone. A line along the dorsum of the foot, from the centre of the ankle-joint to the interval between the inner two toes, will lie over the position of the main artery.

Inner border of the foot. Outer border. Dorsal artery.

Position. The limb is to be raised to a convenient height by blocks beneath the knee, and the foot is to be extended in order that the muscles on the front of the leg may be put on the stretch.

Position of the limb.

Dissection. To enable the dissector to raise the skin from the front of the leg and foot, one incision should be made along the middle line from the knee to the toes, and this should be intersected by cross cuts at the ankle and the root of the toes.

Raise the skin.

After the flaps of skin are reflected, the cutaneous vessels and nerves are to be looked for. At the upper and inner part of the leg are some filaments from the great saphenous nerve; and at the outer side others, still smaller, from the external popliteal nerve. Perforating the fascia in the lower third, on the anterior aspect, the musculo-cutaneous nerve will be found, the branches of which should be pursued to the toes.

Seek the cutaneous nerves in the leg;

On the dorsum of the foot is a venous arch, which ends laterally in the saphenous veins. On the outer side below the malleolus

on the foot both vessels and nerves;

lies the external saphenous nerve; and about the middle of the instep the internal saphenous nerve ceases. In the interval between the great and second toes the cutaneous part of the anterior tibial nerve appears.

clean the fascia.

The digital nerves should be traced to the ends of the toes by removing the integuments; and after the several vessels and nerves are dissected, the fat is to be taken away, in order that the fascia may be seen.

Cutaneous veins:

The VENOUS ARCH on the dorsum of the foot has its convexity turned forwards, and receives digital branches from the toes; at its concavity it is joined by small veins from the instep. Internally and externally it passes into the saphenous veins.

internal saphenous;

The INTERNAL SAPHENOUS VEIN begins at the inner side of the great toe, and in the arch. It ascends in front of the inner malleolus along the inner side of the tibia into the thigh. Branches enter it from the inner border and sole of the foot.

external saphenous.

The EXTERNAL SAPHENOUS VEIN begins on the outside of the little toe and foot, as well as in the venous arch; and it is continued below the outer ankle to the back of the leg (p. 187).

Source of the cutaneous nerves.

CUTANEOUS NERVES (fig. 66). The superficial nerves on the front of the leg and foot are derived mainly from the musculo-cutaneous and anterior tibial branches of the external popliteal trunk, and from the external saphenous nerve from the two popliteals. Some inconsiderable offsets ramify on the front of the leg from the internal saphenous and external popliteal.

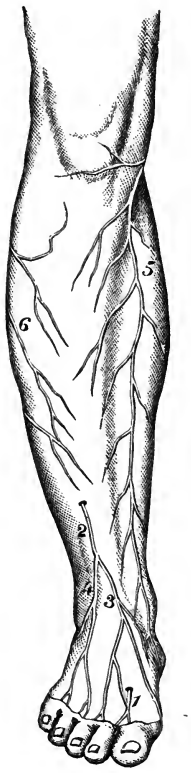


FIG. 66. — CUTANEOUS NERVES OF THE FRONT OF THE LEG AND FOOT.

1. Anterior tibial.
2. Musculo-cutaneous, with 3, its inner, and 4, its outer branch.
5. Internal saphenous.
6. Offsets of external popliteal, lateral cutaneous.

Musculo-cutaneous supplies most of the toes;

The MUSCULO-CUTANEOUS NERVE (2) ends on the dorsum of the foot and toes. Perforating the fascia in the lower third of the leg with a cutaneous artery, it divides into two principal branches (inner and outer), which give dorsal digital nerves to the sides of all the toes, except the outer part of the little toe and the contiguous sides of the great toe and the next. The branches may be traced in the integument as far as the end of the last phalanx :—

divides into inner and

The *inner branch* (3) sends one offset to the inner side of the foot and great toe, and another to the adjacent sides of the second

and third toes: it communicates with the internal saphenous and the anterior tibial nerves.

The *outer branch* (4) also divides into two nerves; these lie over the third and fourth interosseous spaces, and bifurcate at the web of the foot for the contiguous sides of the three toes corresponding with those spaces: it communicates with the external saphenous nerve on the outer border of the foot. outer branch.

The ANTERIOR TIBIAL NERVE (1) becomes cutaneous in the first interosseous space, and is distributed to the opposed sides of the great toe and the next. The musculo-cutaneous nerve communicates with it, and sometimes assists in supplying the same toes. Anterior tibial, where found.

The EXTERNAL SAPHENOUS NERVE (fig. 71, 5, p. 188) comes from the back of the leg below the outer ankle, and is continued along the foot to the outside of the little toe; all the outer margin of the foot receives nerves from it, and the offsets towards the sole are larger than those to the dorsum. Occasionally it supplies both sides of the little toe and part of the next, joining with the outer branch of the musculo-cutaneous. External saphenous.

INTERNAL SAPHENOUS NERVE (fig. 66, 5). This nerve is continued along the vein of the same name to the middle of the instep, where it ceases mostly in the integuments, but some branches pass through the deep fascia to end in the tarsus. Internal saphenous.

The DEEP FASCIA of the front of the leg is thickest near the knee-joint, where it gives origin to muscles. On the inner side it is fixed to the anterior border of the tibia; but externally it is continued round to the back of the leg. A strong intermuscular septum is sent in from the deep surface to the anterior border of the fibula, separating the anterior and external muscles: and another weaker process passes backwards in the upper third of the leg between the tibialis anticus and extensor longus digitorum. Above, the fascia is connected to the heads of the leg-bones; and below, it is continued to the dorsum of the foot. Deep fascia of the leg; intermuscular septa;

Above and below the ankle-joint it is strengthened by some transverse fibres, and gives rise to the two parts of the anterior annular ligament; and below the end of the fibula it forms another band, the external annular ligament. transverse fibres at the ankle.

Dissection. The fascia is to be removed from the front of the leg and the dorsum of the foot, but the thickened bands of the annular ligament (fig. 67) above and below the end of the tibia are to be left. In separating the fascia from the subjacent muscles, let the edge of the scalpel be directed upwards. Take away the fascia,

In like manner the fascia may be taken from the peronei muscles on the outer side of the fibula, but without destroying the band (external annular ligament) below that bone. leave ligamentous bands,

On the dorsum of the foot, the dorsal vessels (fig. 70, p. 183) with their nerve are to be displayed, and the tendons of the short and long extensors of the toes are to be traced to the ends of the digits. In the leg, the muscles are to be cleaned and separated from one another, and the anterior tibial nerve and vessels are to be followed from the dorsum into their intermuscular space, and clean nerves and vessels.

are then to be cleaned as high as the knee, as they lie deeply between the muscles.

Anterior annular ligament :

The ANTERIOR ANNULAR LIGAMENT (fig. 67 and fig. 70, p. 183) consists of two pieces, upper and lower, which confine the muscles in their position, the former serving to bind the fleshy bellies to the bones of the leg, and the latter to keep down the tendons on the dorsum of the foot.

upper, horizontal band,

The *upper part* (*horizontal band*) is above the level of the ankle-joint and is attached laterally to the bones of the leg; it possesses one sheath with synovial membrane for the tibialis anticus.

lower, Y-shaped band ;

The *lower part* is situate in front of the tarsal bones. It is attached externally by a narrow piece into the upper surface of the os calcis, in front of the interosseous ligament; and internally it is thin and widened, having a variously defined thickening at its upper part where it passes to the internal malleolus, and another below where it blends with the fascia on the inner side of the foot; the latter in this place being deep to the tibialis anticus tendon. In view of its single stem externally and the two diverging thickenings internally, this portion of the anterior annular ligament is often called the *Y-shaped band*. Beneath this part of the ligament there are the three sheaths: an inner one for the tibialis anticus; an outer for the extensor longus digitorum and peroneus tertius; and an intermediate one for the extensor hallucis. Separate synovial membranes line the sheaths.

sheaths differ in each.

External annular ligament.

The EXTERNAL ANNULAR LIGAMENT is placed below the fibula, and is attached on the one side to the outer malleolus, and on the other to the os calcis. Its lower edge is connected by fibrous tissue to the sheaths of the peronei muscles on the outer side of the os calcis. It contains the two lateral peronei muscles in one compartment; and this is lined by a synovial membrane, which sends two offsets below into the separate sheaths of the tendons.

Muscles on the front of the leg

The MUSCLES ON THE FRONT OF THE LEG (fig. 67 and fig. 69, p. 181) are four in number. The large muscle next the tibia is the tibialis anticus; that next the fibula, the extensor longus digitorum; while a small muscle, apparently the lower end of the last with a separate tendon to the fifth metatarsal bone, is the peroneus tertius. The muscle between the tibialis and extensor digitorum, in the lower part of the leg, is the extensor proprius hallucis.

and foot.

On the dorsum of the foot only one other muscle appears, the extensor brevis digitorum.

Tibialis anticus: origin;

The TIBIALIS ANTICUS reaches the tarsus: it is thick and fleshy in the upper, but tendinous in the lower part of the leg. It *arises* from the outer tuberosity, and the upper half of the external surface of the tibia (fig. 68); from the contiguous part of the interosseous membrane; and from the fascia of the leg, and the intermuscular septum between it and the extensor longus digitorum. Its tendon begins below the middle of the leg, and passes beneath both pieces of the annular ligament, where it is surrounded by a synovial

insertion;

sheath, to be *inserted* into the internal cuneiform bone, and the metatarsal bone of the great toe.

The muscle is subaponeurotic. It lies at first outside the tibia, resting on the interosseous membrane; but it is then placed successively over the end of the tibia, the ankle-joint, and the inner tarsal bones. On its outer side are the extensor muscles of the toes, and the anterior tibial vessels and nerve. parts in contact;

Action. Supposing the foot not fixed, the tibialis bends the ankle, and raises the inner border of the foot. use on the foot, free

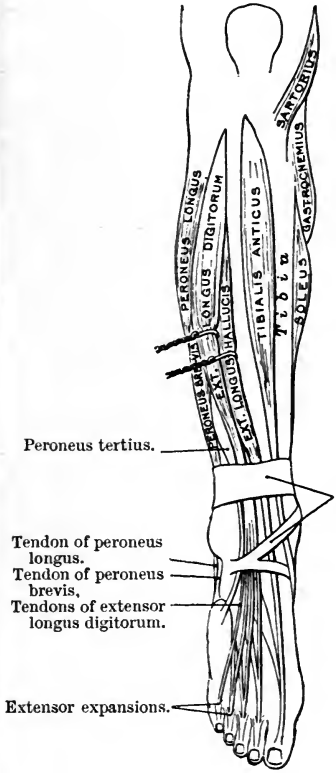


FIG. 67.—MUSCLES ON THE FRONT OF THE LEG.

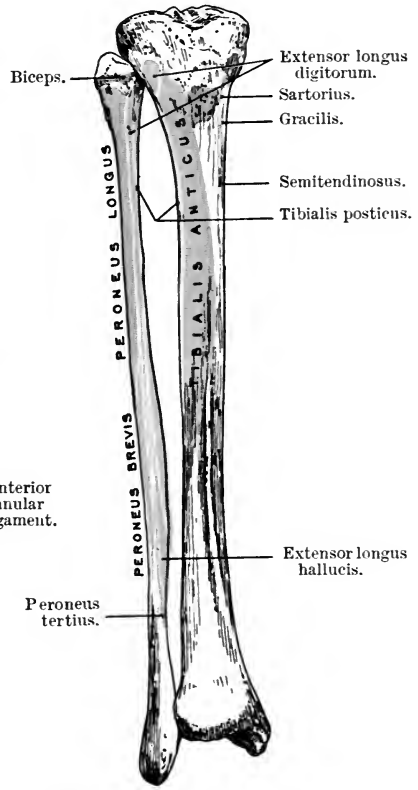


FIG. 68.—THE TIBIA AND FIBULA FROM THE FRONT.

If the foot is fixed, it can, with the tibialis posticus, lift the inner border and support the foot on the outer edge. and fixed

If the tibia is slanting backwards, as when the advanced limb reaches the ground in walking, it can bring forwards and make steady that bone. on the tibia in walking.

The EXTENSOR PROPRIUS HALLUCIS is deeply placed at its origin between the former muscle and the extensor longus digitorum, but its tendon becomes superficial on the dorsum of the foot. The muscle *arises* from the middle two-fourths of the narrow anterior Extensor longus hallucis;

origin from fibula

surface of the fibula (fig. 68), and from the interosseous membrane for the same distance. At the ankle it ends in a tendon, which comes to the surface through a sheath in the lower piece of the

insertion to great toe;

annular ligament, and continues over the tarsus to be *inserted* into the base of the last phalanx of the great toe.

it crosses the vessels;

The anterior tibial vessels lie on the inner side of the muscle at its origin, but afterwards on the outer side of its tendon, so that they are crossed by it in the lower third of the leg.

use on great toe;

Action. It straightens the great toe by extending the phalangeal joints, and afterwards bends the ankle.

on tibia.

When the foot is fixed on the ground and the tibia slants backwards, the muscle can draw forwards that bone.

Extensor longus digitorum:

The EXTENSOR LONGUS DIGITORUM is fleshy in the leg, and tendinous on the foot, like the other muscles. Its *origin* is from the

arises from tibia and fibula;

head, and upper three-fourths of the anterior surface of the fibula, from the external tuberosity of the tibia (fig. 68), from about an inch of the upper part of the interosseous membrane, and from the fascia of the leg and the intermuscular septum on each side of it. The tendon enters its sheath in the annular ligament with the peroneus tertius, and divides into four pieces.

inserted into four outer toes;

Below the ligament these slips are continued to the four outer toes, and are *inserted* into the middle and ungual phalanges in

arrangement of the tendons on the toes;

the following manner. On the first phalanx the tendons of the long and short extensor join with prolongations from the interossei and lumbricales to form an aponeurosis; but there is no tendon from the short extensor to the expansion on the little toe. At the distal end of the first phalanx the aponeurosis is divided into three parts—a central and two lateral; the central piece is inserted into the base of the middle phalanx, and the lateral parts unite at the front of the middle, and are fixed into the last phalanx.

relations of the muscle;

In the leg the muscle is placed between the peronei on the one side, and the tibialis anticus and extensor proprius hallucis on the other. It lies on the fibula, the lower end of the tibia, and the ankle-joint. In the foot the tendons rest on the extensor brevis digitorum; and the vessels and nerve are internal to them.

use on toes and ankle;

Action. The muscle extends the four outer toes, acting mainly on the metatarso-phalangeal joints; it can also bend the ankle-joint.

on tibia.

If the tibia is inclined back, as when the foot reaches the ground in walking, it will be moved forwards by this and the other muscles on the front of the leg.

Peroneus tertius:

The PERONEUS TERTIUS is situate below the extensor longus digitorum, with which it is united. It *arises* from the lower fourth

origin;

of the anterior surface of the fibula (fig. 68), from the lower end of the interosseous membrane, and from the intermuscular septum

insertion;

between it and the peroneus brevis muscle; it is *inserted* into the base of the metatarsal bone of the little toe on the upper surface near its inner border.

This muscle has the same relations in the leg as the lower part of the long extensor, and is contained in the same space in the annular ligament.

Action. The muscle assists the tibialis anticus in bending the ankle; but it differs from that muscle in raising the outer border of the foot, and thus helps the other peronei in producing the movement of eversion. use with tibialis, with peronei.

FIG. 69.—DISSECTION OF THE FRONT OF THE LEG (QUAIN'S ARTERIES).

1. Tibialis anticus muscle.
2. Extensor hallucis and extensor longus digitorum drawn aside.
3. Part of the anterior annular ligament.
4. Anterior tibial artery: the nerve outside it is the anterior tibial.

The ANTERIOR TIBIAL ARTERY (fig. 69) extends from the bifurcation of the popliteal trunk to the front of the ankle-joint. At this spot it becomes the dorsal artery of the foot. Anterior tibial artery:

course and extent; direction;

The course of the artery is forwards through the aperture in the upper part of the interosseous membrane, along the front of that membrane, and over the tibia to the foot. A line drawn along the front of the leg from a point midway between the projection of the outer tuberosity of the tibia and the head of the fibula to the centre of the ankle will mark the position of the vessel.

relations to parts around;

For a short distance (about two inches) the artery lies between the tibialis anticus and the extensor longus digitorum; afterwards it is placed between the tibial muscle and the extensor proprius hallucis as far as the lower third of the leg, where the last muscle becomes superficial and crosses over the vessel to its inner side. The vessel rests on the interosseous membrane in two-thirds of its extent, being overlapped by the fleshy bellies of the contiguous muscles, so that it is at some depth from the surface; but it is placed in front of the tibia and the ankle-joint in the lower third, and is there comparatively superficial between the tendons of the muscles.

position of veins and nerve;

Venæ comites entwine around the artery, covering it very closely with cross branches in the upper part. The anterior tibial nerve approaches the tibial vessels from the outer side in the upper third of the leg, and continues with them, lying along their anterior aspect to their lower end, where it is again on the outer side.

branches:— Muscular. Cutaneous.

Branches. In its course along the front of the leg the anterior tibial artery furnishes numerous *muscular* and *cutaneous branches;* and near the knee and ankle the following named branches take origin:—

Recurrent.

a. The *anterior tibial recurrent artery* is given off as soon as the vessel appears through the interosseous membrane, and ascending through the tibialis anticus, ramifies over the outer tuberosity of the tibia, where it anastomoses with the other articular arteries.

Superior fibular.

b. The *superior fibular branch* runs upwards through the highest part of the extensor longus digitorum to the superior tibio-fibular articulation, to which, with the neighbouring parts, it is distributed.

Malleolar: internal and external.

c. Malleolar branches (internal and external) arise near the ankle-joint, and are distributed over the ends of the tibia and fibula. The *internal* is the smaller, and less constant in origin; it anastomoses with twigs of the posterior tibial artery. The *external* communicates with the anterior peroneal artery (fig. 70), which comes through from the back between the tibia and fibula just above the lower tibio-fibular articulation and will be found to be one of the terminal branches of the peroneal artery (p. 196).

Dorsal artery: extent and course;

The dorsal artery of the foot (fig. 70) is the continuation of the anterior tibial, and extends from the front of the ankle-joint to the upper part of the first interosseous space: at this interval it passes downwards between the heads of the first dorsal interosseous muscle, to end in the sole, where it will be subsequently examined (p. 208).

relations;

The artery rests on the inner part of the tarsus, viz., the astragalus, the navicular, and middle cuneiform bones; and it is covered by the integuments and the deep fascia, and by the inner piece of

the extensor brevis muscle. The tendon of the extensor hallucis lies on the inner side, and that of the extensor longus digitorum on the outer, but neither is close to the vessel.

The veins have the same position with respect to the artery as in the leg; and the nerve is external to it. position of veins and nerve.

Peculiarities. On the dorsum of the foot the artery is often external to a line drawn from the centre of the ankle to the back of the first interosseous Varieties in dorsal artery.

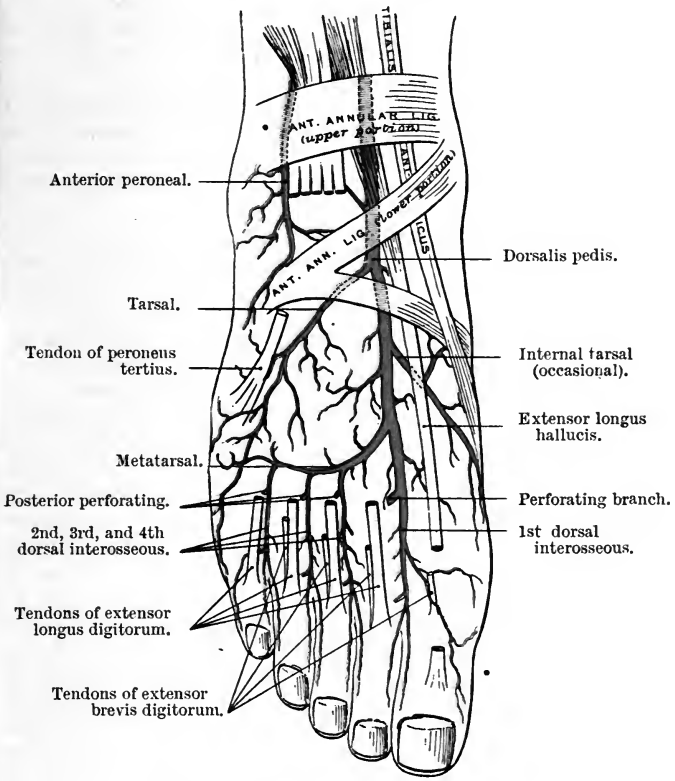


FIG. 70.—ARTERIES ON DORSUM OF FOOT.

space. The dorsal artery may also be reinforced or replaced by a large anterior peroneal branch.

BRANCHES. Small offsets are given to the integuments, and the bones and ligaments of the inner side of the foot. From the outer side of the vessel proceed two larger branches named tarsal and metatarsal; and an interosseous branch is furnished to the first metatarsal space. Branches:—

a. The *tarsal branch* (fig. 70) arises opposite the head of the astragalus, and runs beneath the extensor brevis digitorum to the Tarsal.

outer border of the foot, where it divides into twigs that inosculate with the metatarsal, external plantar, and anterior peroneal arteries : it supplies offsets to the extensor muscle beneath which it lies.

Metatarsal, *b.* The *metatarsal branch* (fig. 70) takes an arched course to the outer side of the foot, near the base of the metatarsal bones and beneath the short extensor muscle, and anastomoses with the external plantar and tarsal arteries.

From the arch of the metatarsal branch three *dorsal interosseous* which gives interosseous, *arteries* are furnished to the three outer metatarsal spaces : and the external of these sends a branch to the outer side of the little toe. They supply the interosseous muscles, and divide at the cleft of the toes into two small dorsal digital branches.

and perforating. At the fore part of the metatarsal space each interosseous branch is usually connected with the corresponding digital artery in the sole of the foot by means of the *anterior perforating twig;* and at the back part of each space a small branch, *posterior perforating*, comes from the plantar arch.

First interosseous. *c.* The *first dorsal interosseous artery* arises from the main trunk as this is about to leave the dorsum of the foot ; it extends forwards in the space between the first two toes, and is distributed like the other dorsal interosseous offsets.

Anterior tibial veins. The ANTERIOR TIBIAL VEINS have the same extent and relations as the vessel they accompany. They take their usual position along the artery, one on each side, and form loops around it by cross branches ; they end in the popliteal vein. The branches they receive correspond with those of the artery ; and they communicate with the internal saphenous vein.

Divide extensor longus. **Dissection.** To examine the extensor brevis digitorum on the dorsum of the foot, cut through the tendons of the extensor longus and peroneus tertius below the annular ligament, and throw them towards the toes. The hinder attachment of the muscle to the os calcis is to be defined.

Extensor brevis digitorum : The EXTENSOR BREVIS DIGITORUM *arises* from the anterior extremity of the os calcis at its upper and outer part, and from the lower band of the anterior annular ligament. Over the metatarsal bones the muscle ends in four tendons, which spring from as many sends tendons to four inner toes ; fleshy bellies, and are *inserted* into the four inner toes. The tendon of the great toe has a distinct attachment to the base of the first phalanx ; but the rest are united to the outer side of the long extensor tendons, and assist to form the expansion on the first phalanx (p. 180).

relations ; The muscle lies on the tarsus, and is partly concealed by the tendons of the long extensor. Its inner belly crosses the dorsal artery of the foot.

use. *Action.* Assisting the long extensor, it straightens the four inner toes, separating them slightly from each other.

Cut through extensor brevis **Dissection.** The branches of artery and nerve which are beneath the extensor brevis will be laid bare by cutting across that muscle near its front, and turning it upwards.

and annular ligament : By dividing the lower band of the annular ligament over the

tendon of the extensor hallucis, and throwing outwards the external half of it, the different sheaths of the ligament, the attachment to the os calcis, and the origin of the extensor brevis digitorum from that bone may be observed.

follow up the nerves.

The anterior tibial and musculo-cutaneous nerves are now to be followed upwards to their origin from the external popliteal; and a small branch to the knee-joint from the same source is to be traced through the tibialis anticus.

Nerves of the front of the leg.

NERVES OF THE FRONT OF THE LEG. Between the fibula and the peroneus longus muscle the external popliteal nerve divides into the musculo-cutaneous and anterior tibial; and from the beginning of the anterior tibial nerve, or the end of the popliteal trunk, a small branch called the recurrent articular is given off.

Recurrent.

The RECURRENT ARTICULAR BRANCH takes the course of the artery of the same name through the tibialis anticus muscle, in which most of its fibres end. A small twig may be followed to the knee-joint.

Musculo-cutaneous supplies peronei.

The MUSCULO-CUTANEOUS NERVE is continued between the extensor longus digitorum and the peronei muscles to the lower third of the leg, where it pierces the fascia, and is distributed to the dorsum of the foot and the toes (p. 176). Before the nerve becomes cutaneous it furnishes branches to the two larger peronei muscles.

Anterior tibial is with the artery:

The ANTERIOR TIBIAL NERVE (fig. 69, p. 181) is directed beneath the extensor longus digitorum, and reaches the tibial artery in the lower part of the upper third of the leg. From this spot it takes the same course as the vessel along the leg and foot to the first interosseous space (p. 182). In the leg it lies for the most part in front of the anterior tibial vessels, but on the foot it is generally external to the dorsal artery and terminates between the first and second toes (p. 177).

branches to muscles.

Branches. In the leg the nerve supplies the anterior tibial muscle, the extensors of the toes, and the peroneus tertius. On the dorsum of the foot it furnishes a considerable branch to the short extensor; this becomes enlarged, and gives offsets to the articulations of the foot.

External muscles of the leg.

MUSCLES ON THE OUTER SIDE OF THE LEG (fig. 67 and fig. 74, p. 192). Two muscles occupy the situation, and are named peroneal from their attachment to the fibula; they are distinguished as long and short. Intermuscular processes of fascia, which are attached to the fibula, isolate these muscles from others.

Peroneus longus: origin from the fibula;

The PERONEUS LONGUS (fig. 67 and fig. 74, G), the more superficial of the two muscles, passes into the sole of the foot round the outer border. It *arises* from the outer tuberosity of the tibia by a small slip, from the head, and the outer surface of the shaft of the fibula for two-thirds of the length, gradually tapering downwards (fig. 68, p. 179), and from the fascia and the intermuscular septa. Inferiorly, it ends in a tendon which is continued through the external annular ligament with the peroneus brevis, lying in the groove at the back of the external malleolus; and it passes finally in a separate sheath below the peroneus brevis along the side of the os calcis, and through the groove in the outer border of the cuboid bone, to the

insertion into bones of the foot; sole of the foot. Its position in the foot and its *insertion* will be described later on (p. 212).

relations in the leg; In the leg the muscle is immediately beneath the fascia, and lies on the peroneus brevis. Beneath the annular ligament it is placed over the middle piece of the external lateral ligament of the ankle with the peroneus brevis, and is surrounded by a single synovial membrane common to both. The extensor longus digitorum and the soleus are fixed to the fibula in front of, and behind it respectively.

use on foot, free, *Action.* With the foot free, the muscle extends the ankle ; then it can depress the inner, and raise the outer border of the foot in the movement of eversion.

and fixed; on the leg. When the foot rests on the ground, it assists to lift the os calcis and the weight of the body, as in standing on the toes, or in walking. And in rising from a stooping posture it draws back the fibula.

Peroneus brevis is attached to The PERONEUS BREVIS (fig. 74, H) reaches the outer side of the foot, and is smaller and deeper than the preceding muscle. It *arises* from the outer surface of the shaft of the fibula for about the lower two-thirds, extending upwards by a pointed piece in front of the peroneus longus (fig. 68), and from the intermuscular septum on each side. Its tendon passes with that of the peroneus longus beneath the external annular ligament, and is placed next the fibula as it turns below this bone. Escaped from the ligament, the tendon enters a distinct fibrous sheath, which conducts it along the tarsus to its *insertion* into the tuberosity at the base of the metatarsal bone of the little toe on the outer side.

fibula, and fifth metatarsal bone;

relations; In the leg the muscle projects in front of the peroneus longus. On the outer side of the os calcis it is contained in a sheath above the tendon of the former muscle; and each sheath is lined by a prolongation from the common synovial membrane behind the outer ankle.

use on foot, free, *Action.* If the foot be unsupported, this peroneus extends the ankle and moves the foot upwards and outwards, everting it.

and fixed; on the leg. If the foot be supported it is able to raise the heel, and to bring back the fibula as the body rises from stooping.

SECTION V.

THE BACK OF THE LEG.

Position. For the dissection of the back of the leg, the limb is to be placed on its front, with the foot over the side of the dissecting table ; and the muscles of the calf are to be put on the stretch by fastening the foot.

Take away the skin. **Dissection.** For the removal of the skin, one cut should be made along the middle of the leg to the sole of the foot, where a transverse incision is to be carried over the heel. The two resulting

flaps of skin may be raised, the outer one as far as the fibula, and the other as far as the inner margin of the tibia.

In the fat the cutaneous nerves and vessels are to be followed. On the inner side, close to the tibia, are the *internal saphenous* vein and nerve, together with twigs of the *internal cutaneous* nerve near the knee. In the centre of the leg lies the *external saphenous* vein, with the small sciatic nerve as its companion above, and the external saphenous nerve below the middle of the leg. On the outer side cutaneous offsets of the external popliteal nerve will be met with. Seek cutaneous nerves in the fat.

The *superficial fascia*, or the fatty layer of the back of the leg, is least thick over the tibia. Along the line of the superficial vessels it may be separated into two layers. Superficial fascia.

Superficial Veins. Two veins appear in the dissection of the back of the leg, the inner and outer saphenous. Two superficial veins.

The internal, or long, saphenous vein (fig. 72, *d*, p. 189) has already been examined in the front of the leg (p. 176), and in this part it will be seen to receive various superficial tributaries and deep roots from the tibial veins. Internal saphenous.

The external, or short, saphenous vein (fig. 71, *c*) has already been examined at its origin (p. 176), and in this part it will be seen to course along the back of the leg to the ham, where it ends in the popliteal vein. It receives large branches about the heel, and others on the back of the leg, communicating with the internal saphenous. External saphenous.

Cutaneous arteries accompany the superficial veins and nerves of the leg. Cutaneous arteries.

Cutaneous Nerves (fig. 71). The nerves in the fat of the back of the leg are prolongations of branches already met with, viz., the internal and external saphenous, external popliteal, small sciatic, and internal cutaneous of the thigh. Cutaneous nerves.

The internal saphenous nerve (fig. 71, 7) has already been examined (pp. 161 and 177), and a few additional twigs will be cleaned in this dissection. Internal saphenous.

The external or short saphenous nerve (fig. 71, 5) is formed by the union of the tibial and peroneal communicating branches of the internal and external popliteal nerves respectively (pp. 129 and 130); the union usually taking place about the middle of the leg. It runs with the external saphenous vein below the outer ankle, and ends on the outer side of the foot and little toe (p. 177). In this part it furnishes twigs to the skin of the lower part of the back of the leg, and large branches over the heel. External saphenous: origin; ending; branches.

Cutaneous nerves of the external popliteal. In addition to the peroneal communicating (fig. 71, 4), the external popliteal nerve gives off one or two lateral cutaneous offsets (p. 130) to the outer side and fore part of the leg. Branches of external popliteal.

The small sciatic nerve (fig. 71, 6) perforates the fascia at the lower end of the popliteal space, and reaches to about the middle of the leg with the external saphenous vein: it ramifies in the integuments, and joins the external saphenous nerve. Termination of small sciatic.

Termination of internal cutaneous.

OFFSET OF THE INTERNAL CUTANEOUS (fig. 71, 8). The posterior branch of the internal cutaneous of the thigh (p. 141) extends to the middle of the leg, and communicates with the internal saphenous nerve.

Take away the fat.

Dissection. The deep fascia will be exposed by removal of the fat, and the superficial vessels and nerves may be either cut or turned aside.

Deep fascia: continuity and attachments.

The DEEP FASCIA on the posterior aspect of the leg covers the muscles, and sends a thick process between the deep and superficial groups. Above, it is continuous with the investing membrane of the thigh, and receives offsets from the tendons about the knee; and below, it joins the annular ligaments. Internally, it is fixed to the edge of the tibia: externally, it is continued uninterruptedly from the one aspect of the limb to the other; but from its deep surface an intermuscular septum is sent inwards between the muscles of the back and those of the outer side of the leg to be attached to the outer border of the fibula. Veins are transmitted through it from the deep to the superficial vessels.

Take away the fascia.

Dissection. The fascia is to be divided along the centre of the leg as far as the heel, and is to be taken from the surface of the gastrocnemius muscle. By fixing with a stitch the cut inner head of the gastrocnemius, the fibres of the muscle will be more easily cleaned.

Muscles in superficial group.

SUPERFICIAL GROUP OF MUSCLES. In the calf of the leg there are three

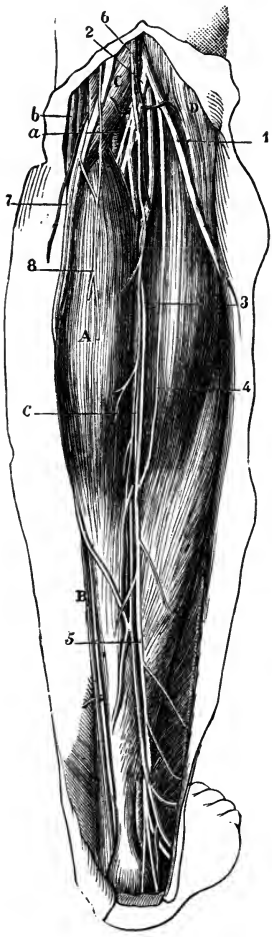


FIG. 71.—FIRST VIEW OF THE BACK OF THE LEG (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Gastrocnemius.
B. Soleus.
C. Semimembranosus.
D. Biceps.

Vessels:

a. Popliteal artery.
b. Internal saphenous vein.
c. External saphenous vein.

Nerves:

1. External popliteal.
2. Internal popliteal.
3. Tibial communicating.
4. Peroneal communicating.
5. External, or short, saphenous.
6. Small sciatic.
7. Internal saphenous.
8. Internal cutaneous.

muscles, gastrocnemius, soleus, and plantaris, which extend the ankle. The first two are large, giving rise to the prominence on the surface, and end below by a common tendon; but the last is inconsiderable in size, and chiefly tendinous.

The GASTROCNEMIUS (fig. 71, A), the most superficial muscle, has two distinct pieces or heads, which *arise* from the lower end of the femur (fig. 61, p. 158). The *inner head* of origin is attached by a large tendon to an impression at the upper aspect of the inner condyle, behind the insertion of the adductor magnus; and by short tendinous fibres to the line above the condyle. The *outer head* is attached by tendon to a pit on the outer surface of the corresponding condyle, above the attachment of the popliteus muscle, and to the posterior surface of the bone immediately above the condyle. The fleshy fibres of the two heads are united along the middle line by a narrow thin aponeurosis, and terminate below with the soleus in the common tendon of insertion.

One surface is covered by the fascia. The other is in contact with the soleus and plantaris, and with the popliteal vessels and the internal popliteal nerve. The heads, by which the muscle arises, assist to form the lateral boundaries of the popliteal space, and are crossed by the tendons of the hamstrings. The inner head is larger, and descends lower than the

Gastrocnemius:

arises by two heads from the femur;

ends below in tendo Achillis;

relations;

FIG. 72.—SECOND VIEW OF THE BACK OF THE LEG (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Gastrocnemius, cut.
B. Soleus.
C. Plantaris.
D. Semimembranosus.
E. Semitendinosus.
F. Tendo Achillis.

Vessels:

a. Popliteal artery.
b. Internal lower articular.
c. External lower articular.
d. Internal saphenous vein.
e. External saphenous vein.

Nerves:

1. External popliteal.
2. Internal popliteal.
3. Short saphenous, cut.

outer. In the outer head a piece of fibro-cartilage or a sesamoid bone may exist.

use with the foot free, and fixed; *Action.* When the foot is unsupported, the gastrocnemius extends the ankle; and when the toes rest on the ground, it raises the os calcis and the weight of the body, as in standing on the toes, and in progression.

acting from below. Taking its fixed point at the os calcis, the muscle draws down the femur so as to bend the knee-joint.

Detach gastrocnemius. **Dissection.** To see the soleus, the gastrocnemius is to be reflected by cutting across the remaining head (fig. 72), and the vessels and nerves it receives. After the muscle has been thrown down, the soleus and plantaris must be cleaned.

Soleus is attached to the bones of the leg, The SOLEUS (fig. 72, B) is a large flat muscle, which is attached to both bones of the leg. It *arises* from the head, and the upper third of the posterior surface of the shaft of the fibula; from the oblique line across the tibia, and from the inner edge of this bone as low as the middle (fig. 73); and between the bones from an aponeurotic arch over the large blood-vessels. Its fibres are directed downwards to the common tendon.

and joins the tendon below;

parts over The superficial surface of the soleus is in contact with the gastrocnemius; and where the two touch they are aponeurotic. Beneath

and under it; the soleus lie the bones of the leg, the deep muscles, and the vessels and nerves.

use, the foot free, and fixed; *Action.* In its action on the foot the soleus, like the gastrocnemius, extends the ankle and points the toes when the foot is free to move, and raises the heel if the toes rest on the ground. By the sudden and powerful contraction of the fibres of both muscles the common tendon is sometimes broken across.

acting from below. If it acts from the os calcis, it will draw back the bones of the leg into a vertical position over the foot, as the body is raised to the erect posture after stooping.

Tendo Achillis: TENDO ACHILLIS (fig. 72, F). The *common tendon* of the gastrocnemius and soleus is one of the strongest in the body. About three

extent, inches wide above, it commences at the middle of the leg, though it receives fleshy fibres on its deep surface nearly to the lower

and insertion. end: below, it is narrowed, and is *inserted* into the middle impression on the posterior aspect of the tuberosity of the os calcis. A bursa intervenes between it and the upper part of the tuberosity. The tendon is close beneath the fascia; and the external saphenous vein and nerve are superficial to it at first, but afterwards lie along its outer border.

Plantaris: The PLANTARIS (fig. 72, C) is remarkable in having the longest tendon in the body, which takes the appearance of a riband when

origin; it is stretched laterally. About three-quarters of an inch wide, the muscle *arises* from the line above the outer condyle of the femur, and from the posterior ligament of the knee-joint; and the tendon

insertion; is *inserted* into the os calcis with, or by the side of, the tendo Achillis, or into the fascia of the leg.

position of the muscle; The belly of the muscle, about three inches in length, is concealed by the gastrocnemius, but the tendon appears on the inner side of

the tendo Achillis about the middle of the leg. This little muscle crosses the popliteal vessels, and lies on the soleus.

Action. It assists slightly the gastrocnemius in extending the ankle if the foot is not fixed, and in bending the knee-joint if the foot is immovable. use like gastrocnemius.

Dissection (fig. 74). The soleus is now to be detached from Detach soleus,

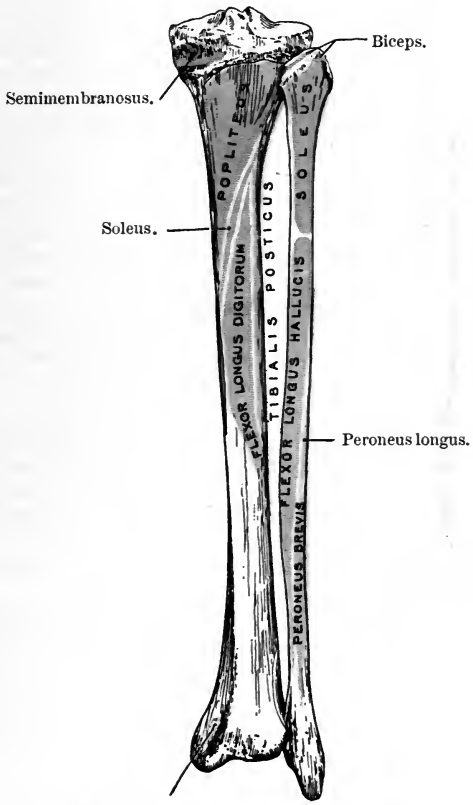


FIG. 73.—THE TIBIA AND FIBULA FROM BEHIND.

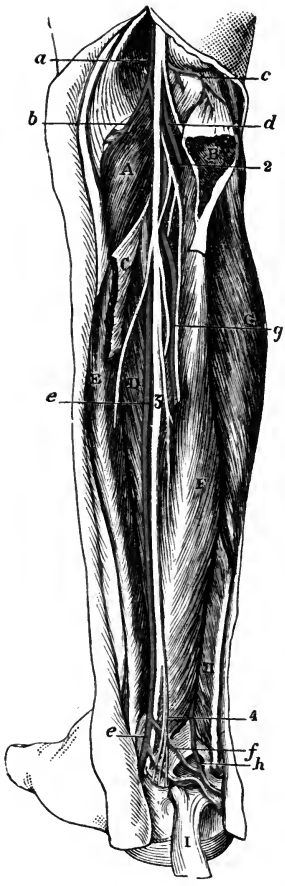
the bones of the leg, and the vessels and nerves entering it are to be divided; but in raising it, the student should take care not to injure the thin deep fascia and the vessels and nerves beneath. The superficial muscles may be next removed by cutting through their tendons near the os calcis; and the bursa between the tendo Achillis and the os calcis should be opened.

The piece of fascia between the muscles of the superficial and deep groups is then to be cleaned; and the integuments between and clean the deep fascia.

Deep part of the fascia of the leg.

Clean the deep muscles;

dissect peroneal artery.



the inner ankle and the heel are to be taken away to lay bare the annular ligament, but a cutaneous nerve to the sole of the foot, which pierces the ligament, is to be preserved.

Deep part of the fascia. This intermuscular piece of the fascia of the leg is fixed to the tibia and fibula, and binds down the flexor muscles of the deep group. In the upper part of the leg it is thin and indistinct; but lower in the limb it is much stronger, and is marked by some transverse fibres near the malleoli, which give it the appearance and office of an annular ligament in that situation. Inferiorly it joins the internal annular ligament between the heel and the inner ankle.

Dissection. The deep layer of muscles, the posterior tibial nerve, and the trunks and offsets of the posterior tibial vessels will be laid bare by the removal of the fascia and the areolar tissue. A muscle between the bones (tibialis posticus) is partly concealed by an aponeurosis which gives origin to the two lateral muscles (flexor longus digitorum and flexor hallucis); and it will not fully appear until after its membranous covering has been divided longitudinally and reflected to the sides.

To prepare the peroneal artery

FIG. 74.—DEEP DISSECTION OF THE BACK OF THE LEG (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Popliteus.
B. Outer, and C, inner part of soleus, cut.
D. Tibialis posticus.
E. Flexor longus digitorum.
F. Flexor longus hallucis.
G. Peroneus longus.
H. Peroneus brevis.
I. Tendo Achillis.

Arteries:

a. Popliteal.
b. Inferior internal, and *c*, inferior external articular.
d. Anterior tibial.
e. Posterior tibial, and *f*, a communicating branch to peroneal.
g. Peroneal.
h. Continuation of peroneal to outer side of the foot.

Nerves:

1. Internal popliteal.
2. Muscular branch of posterior tibial.
3. Posterior tibial.
4. Calcaneo-plantar.

evert and partly divide the flexor hallucis after that muscle has been examined; then define the branches from its lower part to the front of the leg, the outer side of the foot and the one that joins the posterior tibial artery.

DEEP GROUP OF MUSCLES (fig. 74). The deep muscles at the back of the leg are four in number, viz., popliteus, flexor longus hallucis, flexor longus digitorum, and tibialis posticus. The first of these is close to the knee-joint; it crosses the bones, and is covered by a special aponeurosis. The flexors lie on the bones, the one of the great toe resting on the fibula, and that of the other toes on the tibia. And the tibialis covers the interosseous membrane. With the exception of the popliteus, all enter the sole of the foot; and they have a fleshy part parallel to the bones of the leg, and a tendinous part beneath the tarsus.

Four muscles in the deep group: position and destination.

The POPLITEUS (fig. 74, A) *arises* by tendon, within the capsule of the knee-joint, from the front of an oblong depression on the outer surface of the external condyle of the femur (fig. 60, p. 157) and within the capsule of the joint; some fleshy fibres also arise from the posterior ligament. The muscular fibres spread out, and are *inserted* into the tibia above the oblique line on the posterior surface, as well as into the aponeurosis covering them (fig. 73).

Popliteus arises within knee-joint; inserted into tibia;

The muscle rests on the tibia, and is covered by a fascia derived in great part from the tendon of the semimembranosus muscle: on it lie the popliteal vessels and nerve, and the gastrocnemius and plantaris. Along the upper border are the lower internal articular vessels and nerve of the knee; and the lower border corresponds with the attachment of the soleus on the tibia. The tendon of origin will be seen in the dissection of the ligaments of the knee-joint.

parts around it;

Action. The leg being free, the muscle bends the knee-joint, and then rotates the tibia inwards. The popliteus is used especially in beginning the act of flexing the knee, as it produces the rotation inwards of the tibia (or outwards of the femur) without which that movement cannot take place.

use with tibia free; special function.

The FLEXOR LONGUS HALLUCIS (flexor longus pollicis pedis, fig. 74, F) *arises* below the soleus from the lower two-thirds of the posterior surface of the fibula (fig. 73); from the intermuscular septum between it and the peronei muscles, and from the aponeurosis over the tibialis. Inferiorly the tendon of the muscle enters a groove in the astragalus, and crosses the sole of the foot to its insertion into the great toe.

Flexor longus hallucis is attached to fibula;

Above, the muscle is covered by the soleus; but below it is superficial, and is in contact with the fascia. It lies on the fibula and the lower end of the tibia, and conceals the peroneal vessels. Along the inner side are the posterior tibial nerve and vessels; and contiguous to the outer margin, but separated by fascia, are the peronei muscles.

relations;

Action. The foot being unsupported, the flexor bends the last phalanx of the great toe, and then extends the ankle.

use, the foot being free,

The foot resting on the ground, the muscle raises the heel; and it draws the fibula backwards as the body rises from stooping.

and fixed.

Flexor longus digitorum: origin;

The FLEXOR LONGUS DIGITORUM (flexor perforans, fig. 74, E) *arises* from the inner division of the posterior surface of the tibia (fig. 73), extending from the attachment of the soleus to about three inches from the lower extremity, and from the aponeurosis covering the tibialis posticus. Its tendon enters a compartment in the annular ligament, which is external to the sheath of the tibialis; and it divides in the sole of the foot into tendons for the last phalanges of the four outer toes.

enters annular ligament;

part is superficial below soleus;

The muscle is narrow and pointed above, where it is placed beneath the soleus; but in the lower half it is in contact with the fascia, and the posterior tibial vessels and nerve lie on it. The deep surface rests on the tibia and the tibialis posticus.

use, with foot free,

Action. The muscle bends the farthest phalangeal joints of the four smaller toes, and then extends the ankle.

and fixed.

If the toes are in contact with the ground, the flexor helps to raise the heel in walking; and to move back the tibia in the act of rising from stooping.

Tibialis posticus: origin;

The TIBIALIS POSTICUS (fig. 74, D) occupies the interval between the bones of the leg, but it crosses over the tibia below to reach the inner side of the foot. The muscle *arises* (fig. 73 and fig. 68, p. 179) from the interosseous membrane, except about one inch below, from an impression along the outer part of the posterior surface of the tibia extending from the external tuberosity to the middle of the bone, from the inner surface of the shaft of the fibula, and slightly from the aponeurosis covering it. In the lower part of the leg the muscle is directed beneath the flexor digitorum; and its tendon, entering the inner space in the annular ligament, reaches

insertion;

the inner side of the foot to be inserted into the navicular and other bones, as will be seen later (p. 212).

muscles and vessels in relation with it;

The tibialis is concealed by the aponeurosis before mentioned, and is overlapped by the neighbouring muscles; but in the lower part of the leg it is placed between the tibia and the long flexor of the toes. On the muscle are the posterior tibial vessels and nerve. The upper end presents two pointed processes of attachment—that to the tibia being the higher—and between them the anterior tibial vessels are directed forwards.

use, with foot free,

Action. Its action on the movable foot is to depress the fore part and outer side, and carry the toes inwards, producing the movement in the tarsal joints known as inversion (p. 225), and to extend the ankle-joint. The toes resting on the ground, it will aid

and fixed;

the muscles of the calf in raising the heel in the progression of the body.

in standing,

In standing, the muscle can raise the inner border of the foot with the tibialis anticus, so as to throw the weight of the body on the outer edge.

in rising up.

As the body rises from stooping, the tibialis draws back the bones of the leg, with the soleus.

Aponeurosis over the muscle.

The *aponeurosis covering the tibialis* is attached externally to the inner border of the fibula; but internally it joins the flexor longus digitorum without being attached to bone: it may be regarded as

constituting a fibular origin of that muscle. Fibres of the flexor longus hallucis arise from one surface of the membrane, and of the tibialis posticus from the other.

The POSTERIOR TIBIAL ARTERY (fig. 74, *e*) is one of the vessels resulting from the bifurcation of the popliteal trunk (p. 126). It extends from the lower border of the popliteus muscle to the lower edge of the internal annular ligament, where it ends in *internal* and *external plantar* branches for the sole of the foot. Posterior tibial artery: extent;

At its origin the artery lies midway between the tibia and fibula but as it approaches the lower part of the leg it gradually inclines inwards; and at its termination it is placed behind the tibia, in the centre of the hollow between the heel and the inner ankle. course;

For the upper two-thirds of the leg the vessel is concealed by two muscles of the calf, viz., gastrocnemius and soleus; but in the lower third, as it lies between the tendo Achillis and the inner edge of the tibia, it is covered only by the integuments and the deep fascia. At its termination it is placed beneath the annular ligament. For its upper half the trunk lies over the tibialis posticus, but afterwards on the flexor digitorum, and on the lower end of the tibia and the ankle-joint. On the outer side is the flexor hallucis. parts covering it above and below; parts beneath it;

Under the annular ligament, the artery is placed between the tendons of the common flexor of the digits and the special flexor of the great toe. between heel and ankle;

Venæ comites closely surround the vessel. The posterior tibial nerve is at first internal to the artery; but after the origin of the peroneal artery it crosses to the outer side, and retains that position throughout. veins; nerve;

This artery supplies BRANCHES to the muscles and the tibia, and a large PERONEAL trunk to the outer side of the leg. branches:—

a. Muscular branches enter the deep layer of muscles, and the soleus; and an offset from the branch to the soleus pierces the attachment of that muscle to the tibia, and ascends to the knee-joint. Muscular.

b. The *medullary artery* of the tibia arises near the beginning of the trunk; penetrating the tibialis, it enters the canal on the posterior surface of the bone, and ramifies in the interior. Medullary to tibia.

c. Cutaneous offsets appear through the fascia in the lower half of the leg. Cutaneous.

d. One or two small *internal malleolar branches* ramify over the inner malleolus. Internal malleolar.

e. A *communicating branch* arises opposite the lower end of the tibia, and passes outwards beneath the flexor longus hallucis, to unite in an arch with a corresponding offset of the peroneal artery. Sometimes there is a second loop between these vessels superficial to the flexor hallucis (fig. 74, *f*). Communicating.

Peculiarities. If the *posterior tibial artery* is smaller than usual, or absent, its deficiencies in the foot will be supplied by a large communicating branch from the peroneal artery, which, in these cases, is directed inwards at the lower end of the tibia, and either joins the small tibial vessel, or runs alone to the sole of the foot. Size of tibial may vary.

Dissection. The peroneal artery will now be completely exposed by cutting away the flexor longus hallucis as far as may be necessary.

Peroneal artery: The PERONEAL ARTERY (fig. 74, *g*) is often as large as the posterior tibial, and arises from that vessel about one inch from the beginning. It takes the fibula as its guide, and lying close to that bone in a fibrous canal between the origins of the flexor longus hallucis and tibialis posticus, reaches the lower part of the interosseous membrane. At this spot it sends forwards a branch to the front of the leg (*anterior peroneal*) ; and, as the *posterior peroneal*, is directed onwards behind the articulation between the tibia and fibula to the outer side of the heel (*h*), where it terminates in branches, which anastomose with offsets of the tarsal and external plantar arteries. Two companion veins surround the artery ; and the nerve to the flexor hallucis lies on it generally.

courses along fibula, beneath flexor hallucis ; termination; veins and nerve ;

branches :— BRANCHES. Besides the anterior peroneal, it furnishes muscular, medullary, and communicating offsets.

Muscular. *a. Muscular branches* are distributed to the soleus, tibialis posticus, and flexor hallucis ; and some turn round the fibula to the long and short peroneal muscles, lying in grooves in the bone.

Medullary to fibula. *b.* The *medullary artery* is smaller than that to the tibia, and is transmitted through the tibialis posticus to an aperture about the middle of the fibula.

Anterior peroneal to front of foot. *c.* The *anterior peroneal branch* passes forward through an opening below the interosseous membrane, and is continued to the dorsum and outer part of the foot (fig. 70, p. 183) ; on the front of the leg and foot it anastomoses with the external malleolar and tarsal branches of the anterior tibial artery, and has already been exposed (p. 182).

Communicating. *d.* A *communicating offset* near the ankle joins in an arch with a similar branch of the posterior tibial.

Peculiarities. The anterior branch of the peroneal may take the place of the anterior tibial artery on the dorsum of the foot.

Substitutions. A compensating principle may be observed amongst the arteries of the foot, as in those of the hand, by which the deficiency in one is supplied by an enlarged offset of another.

Posterior tibial veins: The POSTERIOR TIBIAL VEINS begin at the inner side of the foot by the union of the plantar venæ comites : they ascend one on each side of the artery, and unite with the anterior tibial at the lower border of the popliteus to form the large popliteal vein. They receive the peroneal veins, and branches corresponding with the offsets of the artery : branches connect them with the saphenous veins.

Posterior tibial nerve : The POSTERIOR TIBIAL NERVE (fig. 74, 3), a continuation of the internal popliteal (p. 129), reaches like the artery from the lower border of the popliteus muscle to the interval between the os calcis and the inner malleolus. While beneath the annular ligament, or somewhat higher than it, the nerve divides into the *internal* and *external plantar* branches of the foot.

extent and relations; Its relations to surrounding muscles are the same as those of the

artery; but its position to the vessel changes, for it lies on the inner side above the origin of the peroneal offset, but thence to the termination, on the outer side. Its branches are muscular and cutaneous. branches

Muscular branches are furnished to the two long flexors, the tibialis posticus, and the soleus. There is an offset for each of the muscles; and they may arise either separately along the trunk, or together from the upper end of the nerve. The branch to the tibialis is the largest; and that to the flexor hallucis lies on the peroneal artery. to muscles.

A cutaneous nerve of the sole of the foot (calcaneo-plantar, fig. 74, [4]) begins above the ankle, and piercing the internal annular ligament as two or more parts, ends in the integuments of the inner and under-parts of the heel: this nerve will be followed to its termination in the dissection of the foot. and to skin of heel and sole.

The INTERNAL ANNULAR LIGAMENT stretches between the heel and the inner ankle, and serves to confine the tendons of the deep layer of muscles of the foot and toes. Attached by a narrow part to the internal malleolus, the fibres diverge, and are inserted into the os calcis. The upper border is continuous with the fascia of the leg; and the lower gives attachment to the abductor hallucis muscle of the foot. Internal annular ligament: attachments

Beneath it are sheaths for the tendons. The innermost sheath encloses the tibialis posticus, lodged in a groove on the back of the malleolus. Immediately outside this is another space for the flexor digitorum. And about three-quarters of an inch nearer the os calcis is the flexor hallucis, resting in a groove in the astragalus. Each sheath is lined by a synovial membrane. Sheaths: their position

Between the tendons of the two flexors of the digits are placed the posterior tibial vessels and nerve.

SECTION VI.

SOLE OF THE FOOT.

Position. The foot is to be placed over a block of moderate thickness with the sole towards the dissector; and the part is to be made tense by fixing the heel with hooks, and by separating and fastening apart the toes. Position of the part.

Dissection. The skin is to be raised in two flaps, inner and outer, by means of one incision along the centre of the sole from the heel to the front and by an incision across the foot at the root of the toes. Afterwards the skin is to be removed from each toe, and the digital vessels and nerves on the sides are to be dissected out at the same time. Raise the skin,

In the fat near the heel the student should follow out the calcaneo-plantar nerve (shown at the upper part of fig. 75, p. 200); and he may trace out, at a little distance from each border of the foot, some small branches of the plantar nerves and arteries. and dissect cutaneous nerves.

Subcutaneous fat.

The *subcutaneous fat* is very abundant, and forms a thick cushion over the parts that press most on the ground in standing, viz., over the os calcis, and the metatarso-phalangeal articulations.

Lay bare the plantar fascia,

Dissection. The fat should now be removed, and the plantar fascia laid bare. Beginning the dissection near the heel, follow forwards the fascia towards the toes, to each of which a process is

and the digital vessels and nerves;

to be traced. In the intervals between these processes the digital nerves and arteries will be detected amongst much fatty and fibrous tissues; but the vessels and nerves to the inner side of the great toe and outer side of the little toe pierce the fascia farther back than the rest.

define the ligament of the toes.

The student is next to define a fibrous band (superficial transverse ligament) across the roots of toes, over the digital vessels and nerves; and when this has been displayed, he may remove the superficial fascia from the toes to see the sheaths of the tendons.

Plantar fascia:

PLANTAR FASCIA. The special fascia of the sole of the foot is of a pearly white colour and great strength, and sends septa between the muscles. Its thickness varies in different parts of the foot; and from this circumstance, and the existence of longitudinal depressions

division into parts.

over the two chief intermuscular septa, the fascia is divided into a central and two lateral pieces.

Central part

The *central part*, which is much the thickest, is pointed at its attachment to the os calcis, but widens and becomes thinner as it extends forwards. A slight depression, corresponding with an intermuscular septum, marks its limit on each side; and opposite

divides into five pieces:

the heads of the metatarsal bones it divides into five processes, which send fibres to the integuments near the web of the foot, and are continued onwards to the toes, one to each. Where the pieces separate from each other, the digital vessels and nerves and the lumbricales muscles become superficial, and are arched over by transverse fibres.

termination of the pieces.

If one of the digital processes be divided longitudinally, and its parts reflected to the sides, it will be seen to join the sheath of the flexor tendons, and to be fixed laterally into the margins of the metatarsal bone, and into the transverse metatarsal ligament.

Inner piece of the fascia.

The *lateral pieces* of the fascia are thinner than the central one. On the inner margin of the foot the fascia has but little strength,

Outer piece.

and is continued to the dorsum; but on the outer side it presents a strong band, which extends between the outer tubercle of the os calcis and the base of the fifth metatarsal bone.

Expose the septa.

Dissection. To examine the septa, a longitudinal incision should be made along the middle of the foot through the central piece of the fascia, and a transverse one near the calcaneum. On detaching the fascia from the subjacent flexor brevis digitorum, by carrying the scalpel from before backwards, the septal processes will appear on the sides of that muscle.

Two intermuscular septa.

The *intermuscular septa* pass deeply on each side of the flexor brevis digitorum, and a piece of fascia reaches across the foot from one septum to the other, beneath that flexor, so as to isolate it.

The *inner* septum separates the short flexor from the abductor hallucis; and the *outer*, from the abductor minimi digiti.

The *superficial transverse ligament* crosses the roots of the toes, and is contained in the skin forming the rudimentary web of the foot. It is attached at the ends to the sheath of the flexor tendons of the great and little toes, and is connected with the sheaths of the others as it lies over them. Beneath it, the digital nerves and vessels issue. Transverse ligament of the toes.

The *sheaths of the flexor tendons* (fig. 77, G, p. 203) on the toes are similar to those of the fingers, though not so distinct, and serve to confine the tendons against the grooved bones. The sheath is weak opposite the articulations between the phalanges, but is strong opposite the centre of both the metatarsal and the next phalanx. Each is lubricated by a synovial membrane, and contains the tendons of the long and short flexor muscles. Sheaths of flexor tendons.

Dissection (fig. 75). In the sole of the foot the muscles are numerous, and have been arranged in four layers. To prepare the first layer, all the fascia must be taken away; but this dissection must be made with some care, lest the digital nerves and vessels, which become superficial to the central muscle towards the toes, should be injured. Dissect first layer of muscles.

The tendons of the short flexor muscle are to be followed to the toes, and one or more of the sheaths in which they are contained should be opened.

FIRST LAYER OF MUSCLES. In this layer are three muscles, viz., the flexor brevis digitorum, the abductor hallucis, and abductor minimi digiti. The short flexor of the toes lies in the centre of the foot; and each of the others is in a line with the toe on which it acts. Muscles in the first layer.

The ABDUCTOR HALLUCIS (fig. 75, A), the most internal muscle of the superficial layer, takes *origin* from the inner side of the larger tubercle on the under-surface of the os calcis (fig. 76), from the plantar fascia, from the lower border of the internal annular ligament, and from the internal intermuscular septum. In front, the muscle ends in a tendon, which is joined by fibres of the short flexor, and is *inserted* into the inner side of the base of the first phalanx of the great toe. Abductor hallucis: origin; insertion;

The cutaneous surface of the muscle is in contact with the plantar fascia; and the other touches the tendons of the tibial muscles, the plantar vessels and nerves, and the tendons of the long flexors of the toes, with the accessorius muscle. relations;

Action. This abductor acts chiefly as a flexor of the metatarso-phalangeal joint of the great toe, but it will slightly abduct that toe from the others. use, as flexor and abductor.

The FLEXOR BREVIS DIGITORUM (flexor perforatus, fig. 75, B) *arises* posteriorly by a pointed process from the fore part of the larger tubercle of the os calcis (fig. 76), from the overlying plantar fascia for two inches and the septa. About the centre of the foot the muscle divides into four slips, which become tendinous and are directed forwards superficial to the tendons of the long flexor to Flexor brevis digitorum

divides into tendons for four toes;

enter the sheaths of the four smaller toes, where they are *inserted* into the middle phalanges. In the sheath on the toe the tendon lies at first (in this position of the foot) on the long flexor; opposite the centre of the first phalanx it is slit for the passage of the long

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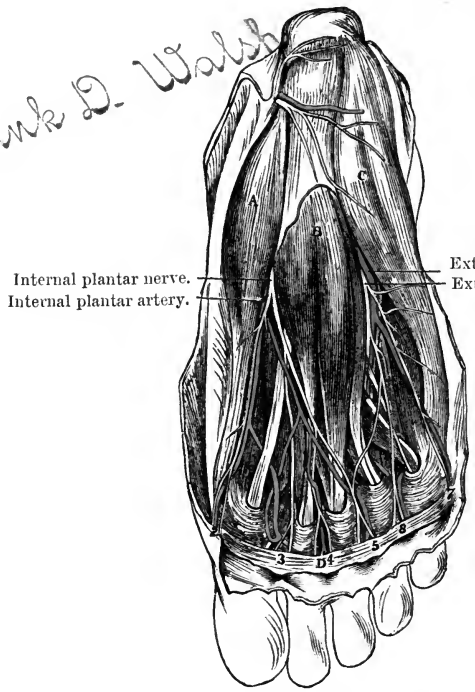

FIG. 75.—FIRST VIEW OF THE SOLE OF THE FOOT (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Abductor hallucis.
B. Flexor brevis digitorum.
C. Abductor minimi digiti.
D. Transverse ligament of the toes.

Arteries:

a. External plantar.
b. Internal plantar.

Nerves:

1. Internal plantar, with its four branches.
2, 3, 4 and 5, for three toes and a half.
6. External plantar nerve, with two digital branches.
7 and 8, for one toe and a half.

insertion; tendon, and it is attached by two processes to the sides of the middle phalanx.

relations; The short flexor of the toes is contained in a sheath of the plantar fascia; and it conceals the tendon of the long flexor of the toes, the flexor accessorius, and the external plantar vessels and nerve.

and use. *Action.* It bends the first and second phalangeal joints of the four smaller toes, like the flexor sublimis in the upper limb, and approximates the toes at same time.

The ABDUCTOR MINIMI DIGITI (fig. 75, c) has a wide *origin* behind from the small outer tubercle of the os calcis, from the adjacent part of the inner tubercle, extending inwards beneath the flexor brevis digitorum (fig. 76), from the outer band of the plantar fascia and from the external intermuscular septum. It ends

Abductor of the little toe: origin and insertion;

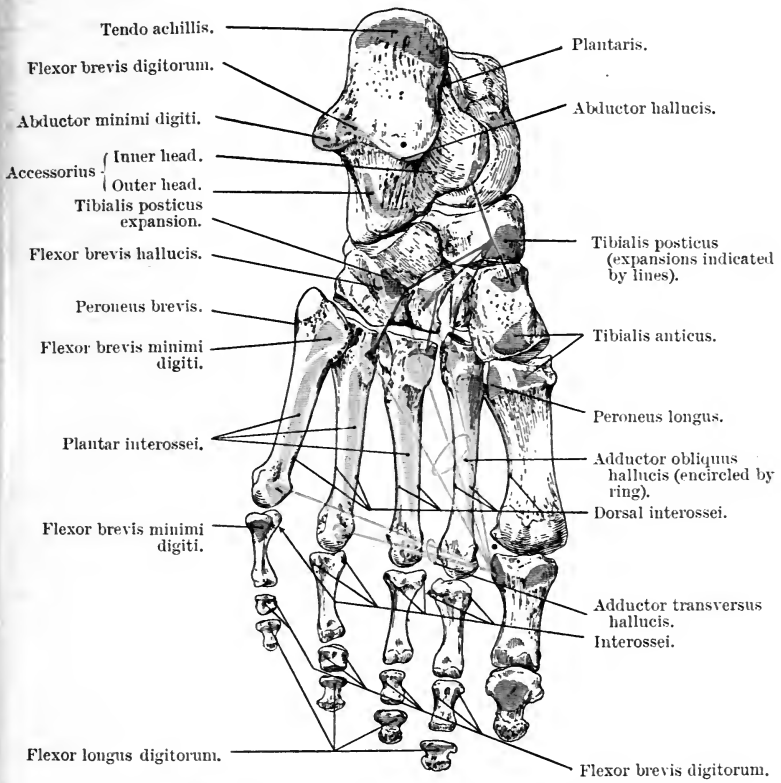

FIG. 76.—MUSCULAR ATTACHMENTS ON PLANTAR ASPECT OF FOOT

anteriorly in a tendon which is *inserted* into the outer side of the base of the first phalanx of the little toe.

The muscle lies along the outer border of the foot, and conceals the flexor accessorius, and the tendon of the peroneus longus. On its inner side are the external plantar vessels and nerves. Sometimes a part of the muscle is fixed into the projection of the fifth metatarsal bone.

relations;

Action. Though it can abduct the little toe from the others, as the name signifies, its chief use is to bend the metatarso-phalangeal joint.

use as abductor and flexor.

Dissect the next muscular layer,

Dissection (fig. 77). To bring into view the second layer of muscles and the plantar vessels and nerves, the muscles already examined must be reflected. Cut through the flexor brevis digitorum at the os calcis, and as it is raised, notice a branch of nerve and artery to it. Divide the abductor minimi digiti near its origin, and in turning it to the outer side of the foot, seek its nerve and vessel close to the calcaneum. The abductor hallucis can be drawn aside if it is necessary, but at present it may remain uncut.

and plantar vessels and nerves.

Next, the internal plantar vessels and nerve are to be followed forwards to their termination, and backwards to their origiu ; and the external plantar vessels and nerve, the tendons of the long flexors of the toes, the accessory muscle, and the small lumbricales, should be freed from fat.

Two plantar arteries : inner and outer.

The PLANTAR ARTERIES (fig. 77) are the terminal branches of the posterior tibial trunk, and supply digital offsets to the toes. They are two in number, and are named external and internal from their relative position in the sole of the foot : the external is the larger, and forms the plantar arch.

Internal small ; course and ending.

The INTERNAL PLANTAR ARTERY (*a*) is inconsiderable in size, and accompanies the internal plantar nerve, under cover of the abductor hallucis, as far as the middle of the foot, where it ends in four superficial digital branches.

Branches to muscles ; and superficial digital ; first, second, third, fourth.

Branches. The artery furnishes muscular branches, like the nerve, to the abductor hallucis, flexor brevis digitorum, and the flexor brevis hallucis. Its digital branches accompany the digital nerves of the internal plantar (fig. 75), and are thus disposed :—

The *first* is distributed to the inner side of the foot and great toe ; the *second* is directed to the first interdigital space ; the *third* to the second space ; and the *fourth* to the third space. At the root of the toes the last three join the deeper digital arteries in those spaces.

External artery has a curved course ; partly superficial, partly deep.

The EXTERNAL PLANTAR ARTERY (*b*) takes an arched course in the foot, with the concavity of the arch turned inwards. The vessel first passes outwards across the sole towards the base of the fifth metatarsal bone, and then turns obliquely inwards towards the root of the great toe, so that it crosses the foot twice. In the first half of its extent, viz., as far as the base of the metatarsal bone of the little toe, the artery is comparatively superficial ; in the other half, between the little and the great toe, it lies deeply in the foot, and forms the plantar arch.

Superficial part :

Only the first part of the artery is now laid bare ; the remaining portion, supplying the digital branches, will be noticed after the examination of the third layer of muscles (p. 207).

relations ;

As far as the metatarsal bone of the little toe, the vessel is concealed by the abductor hallucis and the flexor brevis digitorum ; but for a short distance near its termination it lies in the interval between the last muscle and the abductor minimi digiti. It rests on the os calcis and flexor accessorius ; and it is accompanied by venæ comites and the external plantar nerve.

Branches. From the superficial part of the artery two or three branches to heel, *internal calcaneal branches* arise. They perforate the origin of the

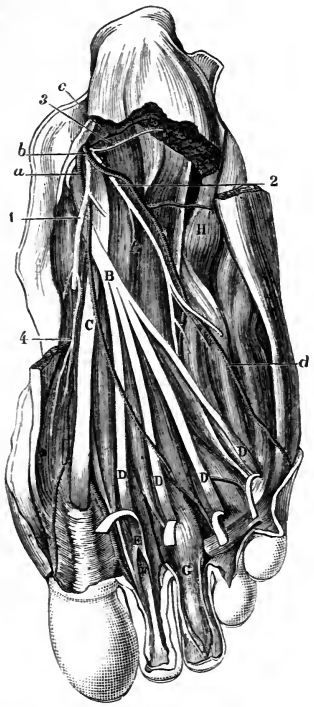

Fig. 77.—Second View of the Sole of the Foot (Illustrations of Dissections).

Muscles :

A. Accessorius.
B. Tendon of flexor longus digitorum.
C. Tendor of flexor longus hallucis.
D, marks the four lumbricales muscles, but the letters are put on the tendons of the flexor perforans.
E. Tendon of flexor brevis digitorum.
F. Tendon of flexor longus digitorum.
G. Sheath of flexor tendons.
H. Tendon of peroneus longus.

Arteries :

a. Internal plantar.
b. External plantar.
c. Branch to abductor minimi digiti.
d. Branch to outer side of little toe.

Nerves :

1. Internal plantar.
2. External plantar.
3. Branch to abductor minimi digiti.
4. Branch to flexor brevis hallucis.

abductor hallucis, and ramify over the heel, anastomosing with the terminal branches of the peroneal artery.

Offsets are also furnished to the muscles between which it lies ; to muscles, and outer side of foot and others turn round the outer border of foot to anastomose with the tarsal and metatarsal arteries.

Plantar nerves also two.

The PLANTAR NERVES (fig. 77) are derived from the bifurcation of the posterior tibial trunk behind the inner ankle. They are two in number, and accompany the plantar arteries; but the larger nerve lies with the smaller blood-vessel.

Internal nerve to three toes and a half;

The INTERNAL PLANTAR NERVE ([1]) courses between the short flexor of the toes and the abductor hallucis, and giving but few muscular offsets, divides into four digital branches (fig. 75, [2], [3], [4], [5]) for the supply of both sides of the inner three toes, and half the fourth; it resembles thus the median nerve of the hand in the distribution of its branches.

muscular branches;

Muscular offsets are given by *the trunk* to the flexor brevis digitorum and the abductor hallucis; and a few *superficial twigs* perforate the fascia.

digital nerves are divided, except first,

The four *digital nerves* have a numerical designation, and the first is nearest the inner border of the foot. The branch ([2]) to the inner side of the great toe is undivided, but the others are bifurcated at the cleft between the toes.

and give muscular branches,

Muscular branches are furnished by two of these nerves before they reach the toes; thus, the first supplies the flexor brevis hallucis; and the second gives a branch to the innermost lumbrical muscle.

cutaneous and articular offsets.

Digital nerves on the toes. Each of the outer three nerves, being divided at the cleft between the toes, supplies the contiguous sides of two toes, while the first belongs altogether to the inner side of the great toe; all give offsets to the integuments, and the cutis beneath the nail, and articular filaments are distributed to the joints as in the fingers.

External plantar to one toe and a half;

The EXTERNAL PLANTAR NERVE (fig. 77, [2]) is spent chiefly in the deep muscles of the sole of the foot, but it furnishes digital nerves to both sides of the little toe, and the outer side of the fourth. It corresponds in its distribution with the ulnar nerve in the hand.

has superficial and deep parts;

It has the same course as the external plantar artery, and divides at the outer margin of the flexor brevis digitorum into a superficial and a deep portion;—the former gives origin to the two digital nerves; but the latter accompanies the arch of the plantar artery into the foot, and will be dissected afterwards (p. 210).

branches to muscles;

While the external plantar nerve is concealed by the short flexor of the toes, it gives *muscular branches* to the abductor minimi digiti and the flexor accessorius.

two digital branches,

one single,

one divided.

The *digital branches* of the external plantar nerve (fig. 75) are two. One ([7]) is undivided and is distributed to the outer side of the little toe, giving offsets to the flexor brevis minimi digiti, and oftentimes to the interosseous muscles of the fourth space. The other ([8]) bifurcates at the cleft between the outer two toes, supplying their collateral surfaces, and communicates in the foot with the last digital branch of the internal plantar nerve.

Distribution like others.

On the sides of the toes the digital nerves have the same distribution as those from the other plantar trunk, and end like them in a tuft of fine branches at the extremity of the digit.

Dissection (fig. 77). To complete the preparation of the second layer of muscles, the abductor hallucis should be detached from the os calcis and turned inwards. The internal plantar nerve and artery, and the superficial portion of the external plantar nerve, are to be cut across and thrown forwards; but the external plantar artery and the nerve with it are not to be injured. All the fat, and the loose tissue and fascia, are then to be taken away near the toes.

Lay bare second layer of muscles.

SECOND LAYER OF MUSCLES (fig. 77). In this layer are the tendons of the two flexor muscles at the back of the leg, viz., flexor longus digitorum and flexor longus hallucis, which cross one another. Connected with the former, soon after it enters the foot, is an accessory muscle; and at its division into tendons for the four outer toes the fleshy lumbricales are added to it.

Muscles of second layer.

The tendon of the FLEXOR LONGUS DIGITORUM (fig. 77, B), enters the foot beneath the annular ligament, and there lies on the internal lateral ligament of the ankle-joint. In the foot it is directed obliquely towards the centre, where it is joined by the accessorius muscle and a slip from the tendon of the flexor longus hallucis, and divides into tendons for the four outer toes.

Tendon of long flexor of toes

divides into four;

Each tendon enters the sheath of the toe with and beneath a tendon from the flexor brevis (E). About the centre of the first phalanx the tendon of the long flexor (F) passes through the other, and goes onwards to be *inserted* into the base of the ungual phalanx. Uniting the flexor tendons with the two nearest phalanges of the toes are short synovial folds, one to each, as in the hand; and the description of the sheaths on p. 75 should be referred to.

these pierce the other tendons;

short folds to tendons;

Action. It flexes the last phalangeal joint, and combines with the short flexor in bending the first and second joints. If it acted by itself it would tend to bring the toes somewhat inwards, in consequence of its oblique position in the foot.

use.

The LUMBRICALES (fig. 77, D) are four small muscles between the tendons of the flexor longus digitorum. Each *arises* from two tendons with the exception of the most internal, which is connected only with the inner side of the tendon to the second toe. Becoming tendinous, they pass upwards on the tibial side of the four outer toes, and are *inserted* into the expansion of the extensor tendons on the dorsum of the first phalanx; but they often end partially in an attachment to the side of the first phalanx. The muscles decrease in size from the inner to the outer side of the foot.

Four lumbricales:

attachment to long flexor

and extensor tendons.

Action. These small muscles assist in flexing the metatarso-phalangeal joints; and through their union with the long extensor tendon they may aid that muscle in straightening the two inter-phalangeal joints.

The ACCESSORIUS MUSCLE (fig. 77, A) has two heads of *origin*:— One is mostly tendinous, and is attached to the outer surface of the os calcis, and to the long plantar ligament; the other is large and fleshy, and springs from the inner concave surface of the bone (fig. 76, p. 201). The fibres end in aponeurotic bands, which join the tendon of the flexor longus digitorum about the centre of the

Flexor accessorius

is joined with flexor longus;

foot, and contribute slips to the pieces of that tendon going to the second, third and fourth digits.

relations; The muscle may be bifurcated behind, and the heads of origin separated by the long plantar ligament. On it lie the externa plantar vessels and nerve; and the muscles of the first layer conceal it.

use. *Action.* By means of its offsets to the tendons of certain digits the muscle helps to bend the toes; and from its position on the outer side of, and behind the long flexor to which it is united, it will oppose the inward pull of that muscle, and enable it to bend the toes more directly backwards.

Insertion of tendon of flexor hallucis; The tendon of the FLEXOR LONGUS HALLUCIS (fig. 77, c) is deeper in the sole of the foot than the flexor longus digitorum: taking a straight course to the root of the great toe, it enters the digital sheath, to be *inserted* into the base of the last phalanx. It is united to the long flexor tendon by a strong tendinous process, which, joined by bands of the accessorius, is continued into the pieces of that tendon belonging to the second and third toes.

relations; Beneath the internal annular ligament this tendon lies in a groove on the back of the astragalus: in the foot it first occupies a similar groove on the under-surface of the sustentaculum tali, and then lies over the flexor brevis hallucis.

use on first and other toes. *Action.* For the action of this muscle on the great toe, see p. 193. Through the slip that it gives to the tendons of the common flexor going to the second and third toes, it will help to bend those digits with the great toe.

Dissect third layer of muscles. **Dissection** (fig. 78, p. 208). For the dissection of the third layer of muscles, the accessorius and the tendons of the long flexors are to be cut through near the calcaneum, and turned towards the toes. While raising the tendons, the external plantar nerve and artery are not to be interfered with; and small nerves and vessels to the outer three lumbricales are to be looked for. Afterwards the areolar tissue is to be taken from the muscles now brought into view.

Muscles of third layer. THIRD LAYER OF MUSCLES (fig. 78). Only the short muscles of the great and little toes enter into this layer. On the metatarsal bone of the great toe the flexor brevis hallucis lies, and external to this is the adductor obliquus hallucis; on the metatarsal bone of the little toe is placed the flexor brevis minimi digiti. Crossing the heads of the metatarsal bones is the adductor transversus hallucis.

The fleshy masses between the adductor obliquus and the short flexor of the little toe consists of the interosseous muscles of the next layer.

Flexor brevis hallucis: The FLEXOR BREVIS HALLUCIS (flexor brevis pollicis pedis, fig. 78, A) *arises* behind by two tendinous slips, one of which is

origin; fixed to the inner side of the cuboid bone (fig. 76, p. 201), while the other is prolonged from the tendon of the tibialis posticus. Near the front of the first metatarsal bone the fleshy belly divides

insertion; into two heads, which are *inserted* into the sides of the base of the metatarsal phalanx.

Resting on the muscle at one part, and in the interval between the heads at another, is the tendon of the flexor longus hallucis. The inner head joins the abductor, and the outer is united with the adductor hallucis. A sesamoid bone is developed in the tendon connected with each head. relations;

Action. By its attachment to the first phalanx it flexes the metatarso-phalangeal joint of the big toe. use.

The ADDUCTOR OBLIQUUS HALLUCIS (adductor pollicis pedis, fig. 78, B), which is larger than the preceding muscle, *arises* from the sheath of the tendon of the peroneus longus, from the ridge on the cuboid, and from the bases of the third and fourth metatarsal bones (fig. 76). Anteriorly the muscle is united with the outer head of the short flexor, and is *inserted* with it into the base of the first phalanx of the great toe. Adductor obliquus hallucis; origin; insertion;

To the inner side is the flexor brevis; and beneath the outer border the external plantar vessels and nerves are directed inwards. relations;

Action. Its first action will be to adduct the great toe to the others, and it will help afterwards in bending the metatarso-phalangeal joint of the toe. use.

The ADDUCTOR TRANSVERSUS HALLUCIS (transversus pedis, fig. 78, D) *arises* by fleshy bundles from the capsules of the meta-tarso-phalangeal articulations of the three outer toes (fig. 76) (frequently not from the little toe), and from the transverse metatarsal ligament. Its *insertion* into the great toe is united with that of the adductor obliquus. Adductor transversus hallucis: origin; insertion;

The cutaneous surface is covered by the tendons and the nerves of the toes; and the opposite surface is in contact with the interosseous muscles and the digital vessels. relations;

Action. It will adduct the great toe to the others, and then approximate the remaining toes. use on the toes.

The FLEXOR BREVIS MINIMI DIGITI (fig. 78, C) is a narrow muscle resembling one of the interossei. *Arising* behind from the base of the fifth metatarsal bone and the sheath of the peroneus longus, it blends in front with the inferior ligament of the metatarso-phalangeal articulation, and is *inserted* into the base of the first phalanx of the toe. Flexor minimi digiti: origin; insertion;

Action. Firstly, it bends the metatarso-phalangeal joint, and next it draws down and adducts the fifth metatarsal bone. use.

Dissection (fig. 79). In order that the deep vessels and nerves may be seen, the flexor brevis and adductor obliquus hallucis are to be cut through behind, and thrown towards the toes; but the nerve supplying the latter is to be preserved. Beneath the adductor lie the plantar arch and the external plantar nerve with their branches; and through the first interosseous space the dorsal artery of the foot enters the sole. All these vessels and nerves, with their branches, require careful cleaning. Dissect the deep vessel and nerves.

The muscles projecting between the metatarsal bones are the interossei; the fascia covering them should be removed.

The PLANTAR ARCH (fig. 79, *d*) is the portion of the external plantar artery which reaches from the base of the metatarsal bone Arch of the plantar artery:

extent; of the little toe to the upper end of the first interosseous space: internally the arch is completed by a communicating branch from the dorsal artery of the foot (p. 182). It is placed across the

relations with muscles, tarsal ends of the metatarsal bones, in contact with the interossei, but under the flexor tendons and the adductor obliquus hallucis.

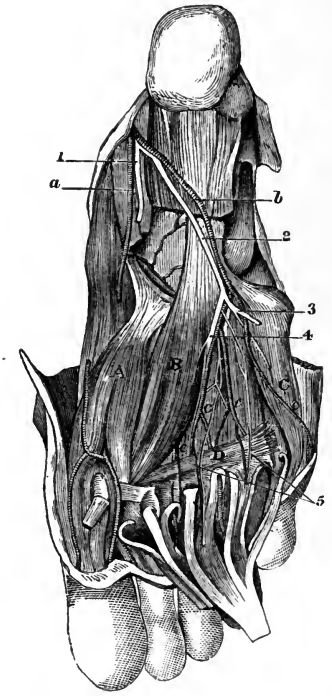

FIG. 78.—THIRD VIEW OF THE SOLE OF THE FOOT (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Flexor brevis hallucis.
B. Adductor obliquus hallucis.
C. Flexor brevis minimi digiti.
D. Adductor transversus hallucis.

Arteries:

a. Internal plantar, cut.
b. External plantar.
c. Its four digital branches.

Nerves:

1. Internal plantar, cut.
2. External plantar.
3. Its superficial part, cut.
4. The deep part, with the plantar arch.
5. Offsets to the outer lumbrical muscles.

veins and nerve; Venæ comites lie on the sides of the artery, and the deep part of the external plantar nerve accompanies it.

branches:— From the front or convexity of the arch the digital branches are supplied, and from the opposite side small nutritive branches arise.

Posterior perforating. Three small arteries, the *posterior perforating*, leave the deep

aspect of the vessel: they pass to the dorsum of the foot through the three outer metatarsal spaces, and join the dorsal interosseous branches (p. 184).

The *digital branches* (*c*) are four in number, and supply both sides of the three outer toes and half the next. One to the outer side of the little toe is single; the others lie over the interossei in the outer three metatarsal spaces, but beneath the adductor transversus hallucis (fig. 78), and bifurcate in front to supply the

Digital branches to

three toes and a half

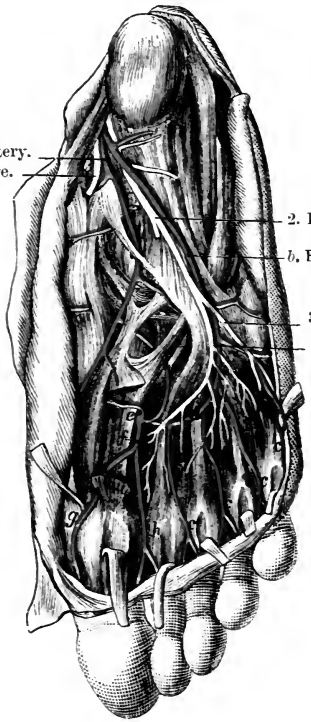

FIG. 79.—FOURTH VIEW OF THE SOLE OF THE FOOT (ILLUSTRATIONS OF DISSECTIONS)

Muscles:

0. Three plantar interossei.
1. Four dorsal interossei.

Arteries:

a. Internal plantar, cut.
b. External plantar.
c. Its four digital branches.
d. Plantar arch.
e. Dorsal of foot entering the sole.
f. Artery of great toe.
g. Branch to inner side of great toe.
h. Branch for the supply of great toe and the next.

Nerves:

1. Internal plantar, cut.
2. External plantar.
3. Its superficial part.
4. Its deep part, the latter supplying offsets to the interosseous muscles.

muscular and anterior perforating offsets; contiguous sides of two toes. They give fine offsets to the interossei, to some lumbricales, and the adductor transversus ; and at the point of division they send small communicating branches—*anterior perforating*, to join the interosseous arteries on the dorsum of the foot (p. 184).

first, The *first digital* runs on the outer side of the little toe, supplying the flexor brevis minimi digiti, and distributes small arteries to the integuments of the outer border of the foot.

second, The *second* belongs to the sides of the fifth and fourth toes, and furnishes a branch to the outer lumbrical muscle.

third, The *third* is distributed to the contiguous sides of the fourth and third toes, and emits a branch to the third lumbricalis.

fourth digital; The *fourth*, or most internal, corresponds with the second interosseous space, and ends like the others on the third and second digits ; it may assist in supplying the third lumbricalis.

junction with inner plantar; The last two are joined by superficial digital branches of the internal plantar at the root of the toes.

distribution on the toes. On the sides of the toes the disposition of the arteries is like that of the digital in the hand (p. 72). They extend to the end, where they unite in an arch, and give offsets to the sides and ball of the toe ; and the artery on the second digit anastomoses at the end of the toe with a branch from the dorsal artery of the foot. Near the front of the first and second phalanges they form anastomotic loops beneath the flexor tendons, from which the phalangeal articulations are supplied.

Ending of the dorsal artery of the foot; The DORSAL ARTERY OF THE FOOT (fig. 79, *e*) enters the sole at the posterior part of the first (inner) metatarsal space, and ends by inosculating with the plantar arch. By a large digital artery it furnishes branches to both sides of the great toe and half the next, in the same manner as the radial artery in the hand is distributed to one digit and a half (p. 80).

its digital branches, The *digital branch* (*f*) extends to the front of the first interosseous space, and divides into collateral branches (*h*) for the contiguous sides of the great toe and the next. Near the head of the metatarsal bone it sends inwards, beneath the flexor muscles, a digital branch (*g*) for the inner side of the great toe.

on the digits. The arteries have the same arrangement along the toes as the other digital branches ; and that to the second digit anastomoses at the end with a branch of the plantar arch.

External plantar nerve ends in the deep muscles: The DEEP PART OF THE EXTERNAL PLANTAR NERVE (fig. 79, [4]) accompanies the arch of the artery, and ends internally in the adductor obliquus hallucis. It furnishes branches to all the interossei, to the transversus adductor, and to the outer three

like ulnar nerve. lumbrical muscles (Brooks). This nerve corresponds with the deep portion of the ulnar nerve in the hand.

Dissection. **Dissection.** It will be needful to remove the transverse adductor muscle to see a ligament across the heads of the metatarsal bones.

Transverse metatarsal ligament. The TRANSVERSE METATARSAL LIGAMENT is a strong fibrous band, like that in the hand (p. 81), which connects together all the

metatarsal bones at their anterior extremity. A thin fascia covering the interosseous muscles is attached to its hinder edge. It is concealed by the adductor transversus hallucis, and by the tendons, vessels, and nerves of the toes.

Dissection. To complete the dissection of the last layer of muscles, the flexor brevis minimi digiti may be detached and thrown forwards. Dividing then the metatarsal ligament between the bones, the knife is to be carried directly backwards for a short distance in the centre of each interosseous space, except the first, in order that the two interosseous muscles may be separated from each other. All the interossei are visible in the sole of the foot. Dissect the last layer of muscles.

The fascia covering the muscles should be taken away if any remains, and the branches of the external plantar nerve to them should be dissected out.

FOURTH LAYER OF MUSCLES (fig. 79). In the fourth and last layer of the foot are contained the interosseous muscles, and the tendons of the tibialis posticus and peroneus longus. Fourth layer of muscles.

The INTEROSSEOUS MUSCLES (fig. 79) are situate in the intervals between the metatarsal bones : they consist of two sets, plantar and dorsal, like the interossei in the hand. Seven in number, there are three plantar and four dorsal ; and two are found in each space, except the innermost. Interossei.

The *plantar muscles* (o) are slender fleshy slips, belonging to the outer three toes. Each *arises* from the under and inner surface of the corresponding metatarsal bone (fig. 76, p. 201) ; and is *inserted* partly into the tibial side of the base of the first phalanx of the same toe, and partly by an expansion to the extensor tendons on the dorsum of the phalanx. These muscles are smaller than the dorsal, and are placed more in the sole of the foot. Three plantar for three outer toes.

The *dorsal muscles* (1), one in each space, *arise* by two heads from the lateral surfaces of the bones between which they lie, (fig. 76), and are *inserted* like the others into the side, and on the dorsum of the metatarsal phalanx of certain toes. Thus, the inner two muscles belong to the second toe, one to each side ; the next belongs to the outer side of the third toe ; and the remaining one to the outer side of the fourth toe. Four dorsal between the bones.

The interossei are crossed by the external plantar vessels and nerve, and their digital branches ; and they lie beneath the adductor transversus hallucis and the metatarsal ligament. The posterior perforating arteries pierce the hinder extremities of the dorsal set. Relations.

Action. Like the interossei of the hand (p. 81), they will contribute to the bending of the metatarso-phalangeal joints, and straighten the two interphalangeal joints. Use as flexors, and extensors ;

They can act also as abductors and adductors of the toes. Thus, the plantar set will bring the three outer toes towards the second toe ; and the dorsal muscles will abduct from the middle line of the second toe,—the two attached to that digit moving it to the right and left of the said line. as adductors, and abductors.

Trace out the deep tendons.

Dissection. Follow the tendon of the tibialis posticus muscle from its position behind the inner malleolus to its insertion into the navicular bone, and trace the numerous processes that it sends forwards and outwards (fig. 76). Open also the fibrous sheath of the tendon of the peroneus longus, which crosses from the outer to the inner side of the foot.

Insertion of tendon of tibialis posticus

The tendon of the TIBIALIS POSTICUS is continued forwards over the internal lateral ligament of the ankle-joint and the internal calcaneo-navicular ligament, to be *inserted* into the tuberosity of the navicular bone. From its insertion processes are continued to many

into tarsus

of the other bones of the foot :—One is directed backwards to the sustentaculum tali of the os calcis. Two offsets are directed forwards ;—one to the internal cuneiform bone, the other, much the larger, is attached to the middle and outer cuneiform, to the cuboid

and metatarsus.

bone, and to the bases of the second, third, and fourth metatarsal bones. In other words, extensions pass into all the tarsal bones except one (astragalus), and into all the metatarsal bones except two (first and fifth).

Where the tendon is placed over the calcaneo-navicular ligament, it contains a fibro-cartilage, or occasionally a sesamoid bone.

Insertion of tendon of peroneus longus:

The tendon of the PERONEUS LONGUS MUSCLE winds round the cuboid bone, and is continued inwards in the groove on the under-surface to be *inserted* into the internal cuneiform bone and the base of the metatarsal bone of the great toe ; and sometimes by a slip into the base of the second metatarsal bone.

relations.

In the sole of the foot (fig. 79), it is contained in a sheath which is completed, towards the outer part, by the fibres of the long plantar ligament prolonged to the tarsal ends of the third and fourth metatarsal bones ; but it is formed internally only by areolar tissue. A synovial membrane lubricates the sheath.

Where the tendon turns round the cuboid bone it is thickened, and contains a fibro-cartilage or a sesamoid bone.

SECTION VII.

LIGAMENTS OF THE KNEE, ANKLE, AND FOOT.

Examine first the knee-joint.

Directions. In examining the remaining articulations of the limb, the student may take first the knee-joint, unless this has become dry ; in that case the ligaments of the leg, ankle-joint, and foot may be dissected while the knee is being moistened.

Dissection to see knee,

Dissection. For the preparation of each ligament of the knee-joint, it is sufficient to detach the muscles and tendons from around it, and to remove the areolar tissue or fibrous structure which may

capsule,

obscure or conceal the ligamentous band. A kind of aponeurotic

and tendons.

capsule is to be defined on the front of the joint ; and some tendons, namely, those of the biceps, popliteus, adductor magnus,

and semimembranosus, are to be followed to their insertion, a part of each being left.

ARTICULATION OF THE KNEE. The knee is the largest joint in the body, and is formed by the contiguous ends of the tibia and femur, and of the patella. The articular surfaces of the bones are covered with cartilage, and are maintained in apposition by strong and numerous ligaments. Bones in the knee-joint.

The *capsule* (fig. 80) is an aponeurotic covering on the front of the joint, which closes the wide intervals between the anterior and the lateral ligaments; and it is derived from the fascia lata united with fibrous offsets of the extensor and flexor muscles. It covers Capsule: how formed.

FIG. 80.—EXTERNAL ASPECT OF THE KNEE-JOINT (BOURGERY).

1. Anterior ligament.
2. External lateral ligament.
3. Interosseous membrane.
4. Lower extremity of the ilio-tibial band of the fascia lata, forming part of the capsule.

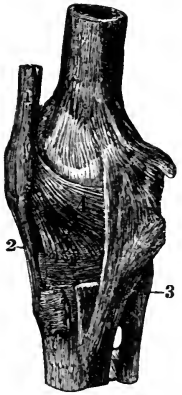

FIG. 81.—INTERNAL ASPECT OF THE KNEE-JOINT (BOURGERY).

1. Tendon of the extensor muscle, ending below in the ligament of the patella, 2.
3. Internal lateral ligament.
4. Inner part of the capsule.

the anterior and the external lateral ligaments, being inserted below into the heads of the tibia and fibula; and it blends on the inner side with the internal lateral ligament. It is separated from the synovial membrane by the anterior ligament and by fat. arrangement.

Dissection. Four additional ligaments, anterior and posterior, internal and external lateral, are situate at opposite parts of the articulation. The posterior and the internal lateral ligaments will appear on the removal of the areolar tissue from their surfaces; but the anterior and the external lateral are covered by the aponeurosis on the front of the joint, and will not be laid bare till this has been cut through. If there is a second external lateral band present, it is not concealed by the aponeurosis. The external ligaments. To define the ligaments how to proceed.

The *external lateral ligament* (fig. 80, 2) is round and cord-like. It is attached to the tuberosity of the outer condyle of the femur, External lateral ligament is small:

below the tendon of the gastrocnemius, and descends vertically, partially subdividing the tendon of the biceps, to a depression on the upper and outer part of the head of the fibula. Beneath the ligament are the tendon of the popliteus and the external lower articular vessels and nerve.

occasional band.

A second fasciculus is sometimes present behind the other, but it is not attached to the femur; it is connected above with the outer head of the gastrocnemius, and below with the styloid process of the head of the fibula.

Tendon of the biceps is divided.

The *tendon of the biceps* is inserted by two main pieces into the head of the fibula; and from both of these fibres are prolonged to the head of the tibia. The external lateral ligament passes between these pieces into which the tendon is partially split.

Tendon of the popliteus,

The *tendon of the popliteus* may be followed by dividing the posterior ligament. It arises from the fore part of the oblong depression on the outer surface of the external condyle of the femur. In its course to the outside of the joint, it crosses the external semilunar fibro-cartilage and the upper tibio-peroneal articulation. When the joint is bent, the tendon lies in the hollow on the condyle; but it slips out of that groove when the limb is extended.

and of adductor magnus.

The *tendon of the adductor magnus* is inserted into the adductor tubercle on the internal condyle of the femur, above the attachment of the internal lateral ligament.

Internal lateral ligament: attachments;

The *internal lateral ligament* (fig. 81, [3]) is attached above to the condyle of the femur, where it blends with the capsule; but becoming broadened out and thicker below, and separate from the rest of the capsule, it is fixed for about an inch into the inner surface of the tibia, below the level of the ligamentum patellæ: some of the deeper fibres join the internal semilunar fibro-cartilage.

is joined by semimembranosus.

The tendons of the sartorius, gracilis, and semitendinosus muscles lie over this ligament; and the tendon of the semimembranosus, and the internal lower articular vessels and nerve are beneath it. To the posterior edge some fibres from the tendon of the semimembranosus are added.

Insertion of the semimembranosus.

The *tendon of the semimembranosus muscle* is inserted beneath the internal lateral ligament into the lower part of the groove at the back of the inner tuberosity of the tibia: between it and the upper edge of the groove is a synovial bursa. The tendon sends a few fibres into the internal lateral ligament, a prolongation to join the fascia on the popliteus muscle, and another to the posterior ligament of the knee-joint (fig. 52, p. 128).

Posterior ligament.

The *posterior ligament* is wide and membranous, and is formed in great part by a strong process from the tendon of the semimembranosus, which is directed across the joint to the outer side. It is fixed below to the head of the tibia behind the articular surface; and above, it is attached in the centre to the femur at the upper border of the intercondylar notch, but on each side it joins the tendinous head of the gastrocnemius. Numerous apertures exist in it for the passage of vessels and nerves to the interior of the

articulation; and the tendon of the popliteus pierces its outer part.

The *anterior ligament* or *ligamentum patellæ* (fig. 81, [2]) is the infrapatellar part of the tendon of insertion of the extensor muscle of the knee. About two inches long, it is attached above to the apex and lower border of the patella; and below to the tubercle of the tibia. An expansion of the quadriceps extensor covers it; and a bursa intervenes between it and the front of the tibia above the tubercle. Anterior ligament is infra-patellar tendon.

Dissection (fig. 82). To see the reflections of the synovial membrane, raise the knee on blocks, and open the joint in front by an Open the knee-joint in front

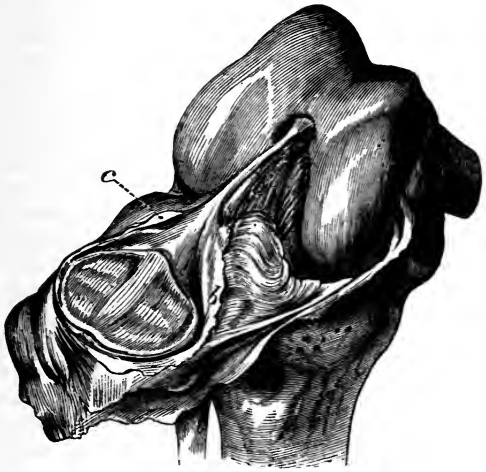

FIG. 82.—INTERIOR OF THE KNEE-JOINT, THE CAPSULE OF THE KNEE-JOINT CUT ACROSS, AND THE PATELLA THROWN DOWN, TO SHOW THE NAMED FOLDS OF THE SYNOVIAL SAC.

a. Mucous ligament.
b. Internal, and *c*, external alar ligament.

incision on each side above the patella. When the anterior portion of the capsule with the patella is thrown down, a fold (mucous ligament) will be seen extending from the intercondylar fossa of the femur to a mass of fat below the patella. On each side of the patella is another fold (alar ligament) also over some fat.

The limb may be laid flat on the table, and some of the posterior ligament removed, to show the pouches of the synovial membrane which project behind over the condyles of the femur; but the limb is to be replaced in the former position before the parts are learnt. and behind.

The *synovial membrane* (fig. 82) lines the interior of the joint, and is continued to the margins of the articular surfaces of the bones. It invests the interarticular fibro-cartilages after the manner Synovial membrane

below the tendon of the gastrocnemius, and descends vertically, partially subdividing the tendon of the biceps, to a depression on the upper and outer part of the head of the fibula. Beneath the ligament are the tendon of the popliteus and the external lower articular vessels and nerve.

occasional band.

A second fasciculus is sometimes present behind the other, but it is not attached to the femur; it is connected above with the outer head of the gastrocnemius, and below with the styloid process of the head of the fibula.

Tendon of the biceps is divided.

The *tendon of the biceps* is inserted by two main pieces into the head of the fibula; and from both of these fibres are prolonged to the head of the tibia. The external lateral ligament passes between these pieces into which the tendon is partially split.

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The *tendon of the adductor magnus* is inserted into the adductor tubercle on the internal condyle of the femur, above the attachment of the internal lateral ligament.

Internal lateral ligament: attachments;

The *internal lateral ligament* (fig. 81, [3]) is attached above to the condyle of the femur, where it blends with the capsule; but becoming broadened out and thicker below, and separate from the rest of the capsule, it is fixed for about an inch into the inner surface of the tibia, below the level of the ligamentum patellæ: some of the deeper fibres join the internal semilunar fibro-cartilage.

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The tendons of the sartorius, gracilis, and semitendinosus muscles lie over this ligament; and the tendon of the semimembranosus, and the internal lower articular vessels and nerve are beneath it. To the posterior edge some fibres from the tendon of the semimembranosus are added.

Insertion of the semimembranosus.

The *tendon of the semimembranosus muscle* is inserted beneath the internal lateral ligament into the lower part of the groove at the back of the inner tuberosity of the tibia: between it and the upper edge of the groove is a synovial bursa. The tendon sends a few fibres into the internal lateral ligament, a prolongation to join the fascia on the popliteus muscle, and another to the posterior ligament of the knee-joint (fig. 52, p. 128).

Posterior ligament.

The *posterior ligament* is wide and membranous, and is formed in great part by a strong process from the tendon of the semimembranosus, which is directed across the joint to the outer side. It is fixed below to the head of the tibia behind the articular surface; and above, it is attached in the centre to the femur at the upper border of the intercondylar notch, but on each side it joins the tendinous head of the gastrocnemius. Numerous apertures exist in it for the passage of vessels and nerves to the interior of the

articulation; and the tendon of the popliteus pierces its outer part.

The *anterior ligament* or *ligamentum patellæ* (fig. 81, [2]) is the infrapatellar part of the tendon of insertion of the extensor muscle of the knee. About two inches long, it is attached above to the apex and lower border of the patella; and below to the tubercle of the tibia. An expansion of the quadriceps extensor covers it; and a bursa intervenes between it and the front of the tibia above the tubercle. Anterior ligament is infra-patellar tendon.

Dissection (fig. 82). To see the reflections of the synovial membrane, raise the knee on blocks, and open the joint in front by an Open the knee-joint in front

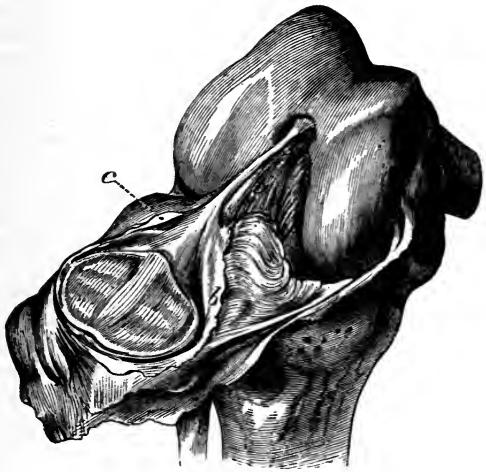


FIG. 82.—INTERIOR OF THE KNEE-JOINT, THE CAPSULE OF THE KNEE-JOINT CUT ACROSS, AND THE PATELLA THROWN DOWN, TO SHOW THE NAMED FOLDS OF THE SYNOVIAL SAC.

a. Mucous ligament.
b. Internal, and *c*, external alar ligament.

incision on each side above the patella. When the anterior portion of the capsule with the patella is thrown down, a fold (mucous ligament) will be seen extending from the intercondylar fossa of the femur to a mass of fat below the patella. On each side of the patella is another fold (alar ligament) also over some fat.

The limb may be laid flat on the table, and some of the posterior ligament removed, to show the pouches of the synovial membrane which project behind over the condyles of the femur; but the limb is to be replaced in the former position before the parts are learnt. and behind.

The *synovial membrane* (fig. 82) lines the interior of the joint, and is continued to the margins of the articular surfaces of the bones. It invests the interarticular fibro-cartilages after the manner Synovial membrane

of serous membranes, and sends a pouch between the tendon of the popliteus and the external fibro-cartilage and the head of the tibia; it is also reflected over the strong crucial ligaments at the back of the joint.

thrown into folds named ligaments,—mucous,

There are three named folds of the synovial membrane. One in the centre of the joint is the *mucous ligament* (*a*), which contains small vessels and some fat, and extends from the interval between the condyles to the fat below the patella. Below and on each side

and alar.

of the patella is another fold—*alar ligament* (*b* and *c*), which is continuous with the former below the patella, and is placed over a mass of fat: the inner (*b*) is prolonged farther than the outer by a semilunar piece of the synovial membrane.

Synovial pouches: two behind

At the back and front the articulation pouches are prolonged beneath the tendons of muscles. Behind there are two, one on each side, between the condyle of the femur and the tendinous head of the gastrocnemius. On the front, the sac projects under the extensor

and one before.

muscle one inch above the articular surface; and if it communicates with the bursa in that situation, as is usually the case, it will reach two inches above the joint-surface of the femur. When the joint is bent there is a still greater length of the serous sac above the patella.

Articular fat:

Fat around the joint. Two large masses are placed above and below the patella, and a smaller quantity of fat surrounds the crucial ligaments.

below patella,

The infrapatellar mass, the largest of all, fills the interval between the patella with its ligament and the head of the tibia, and gives origin to the ridges of the synovial membrane. From it a piece is continued round the patella; but it is larger at the inner margin than at the outer, and overhangs the inner perpendicular facet of that bone. This infrapatellar pad adapts itself to the varying shape

use;

and extent of the angular interspace between the bones and the ligamentum patellæ in the movements of the joint.

above the patella.

The suprapatellar pad is interposed between the common extensor tendon and the femur round the top of the synovial sac, and is larger on the outer than the inner side.

Dissect internal ligaments.

Dissection (fig. 83). The ligamentous structures within the capsule will be brought into view, while the limb is still in the same position, by throwing down the patella and its ligament, and clearing away the fat behind it. In this step the student must be careful of a small transverse band which connects anteriorly the interarticular fibro-cartilages.

The remains of the capsule and other ligaments, and the synovial membrane, are next to be cleared away from the front and back of the crucial ligaments, and from the fibro-cartilages. While cleaning the posterior crucial ligament, the limb is to be placed flat on the table with the patella down, and the student is to be careful of a band in front of the ligament from the external fibro-cartilage, or of two bands, one before and the other behind it.

Ligaments within the capsule.

Ligaments within the capsule. The ligamentous structures within the capsule consist of the central crucial ligaments, and of two plates of fibro-cartilage on the head of the tibia.

The *crucial ligaments* (fig. 83) are two strong fibrous cords between the ends of the tibia and femur, which maintain the bones in contact. They cross one another like the legs of the letter X, and have received their name from that circumstance. One is much anterior to the other at the tibial attachment. Two crucial ligaments.

The *anterior ligament* (*f*) is very oblique in its direction, and is longer than the posterior. Inferiorly it is attached in front of the spine of the tibia, close to the inner articular surface, reaching back to the inner point of the spine; superiorly it is inserted into an impression on the hinder part of the inner surface of the external condyle of the femur. Anterior is oblique; its attachments.

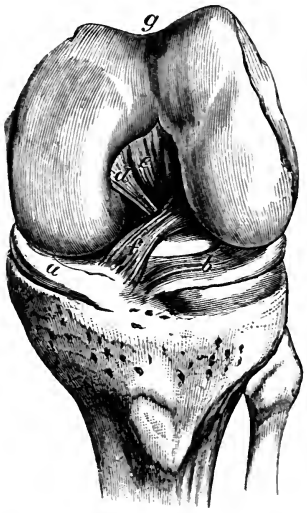


Fig. 83.—Interarticular Ligaments of the Knee-joint.

a. Internal, and *b*, external semilunar fibro-cartilage; the latter rather displaced by the bending of the joint.

e. Posterior crucial ligament, with *d*, the ascending ligamentous band of the external fibro-cartilage.

f. Anterior crucial ligament.

g. Patellar surface of the femur.

The *posterior ligament* (*e*), the thicker of the two, is almost vertical between the bones at the back of the joint. By the lower end it is fixed to the hindmost impression of the hollow behind the spine of the tibia, near the margin of the bone; and above, it is inserted into an impression at the lower part of the outer surface of the internal condyle, and extending forwards to the centre of the intercondylar fossa. Posterior is vertical; its attachments.

The *use* of these ligaments in the movements of the joint may now be studied after the external ligaments have been cut through. Their use.

As long as both ligaments are whole, the bones cannot be separated from each other. Both unite the bones.

Rotation inwards of the tibia is limited by the anterior crucial. Rotation out is not checked by either ligament; for the bands uncross in the execution of the movement, and will permit the tibia to be turned hind part foremost. Rotation inwards checked by anterior.

Supposing the tibia to move as in straightening the limb, the anterior prevents that bone being carried too far forwards by the extensor muscle, or by external force; and the ligament is brought into action at the end of extension, because the tibia is being put in front of the femur. Its use is shown by cutting it across, and leaving the posterior entire, as then the tibial articulating surfaces can be placed in front of the femoral in the half-bent state of the joint. Special use of anterior,

The posterior crucial prevents displacement backwards of the tibia by the flexors or by force; and it is stretched in extreme and posterior crucial.

flexion, in which the tibia is being drawn back over the femur. This use will be exemplified by cutting across the posterior (in another joint or in another dissection) and leaving entire the anterior; when this has been done, the articular surfaces of the tibia can be carried nearly altogether behind the condyles of the femur.

Semilunar cartilages are two.

The two *interarticular* or *semilunar fibro-cartilages* (fig. 84) partly cover on each side the articular surface of the tibia.

Common characters.

They are thick at the convex margin, where they are united by fibres to the capsule, and are thin, sharp, and free at the concave edge; they are hollowed on the upper surface, so as to assist in giving depth to the fossæ for the reception of the condyles of the femur, but are flattened below. Inserted into the tibia at their extremities, they are coarsely fibrous at their attachment to the bone, like the crucial ligaments; and they become cartilaginous only where they lie between the articular surfaces. The synovial membrane is reflected over them.

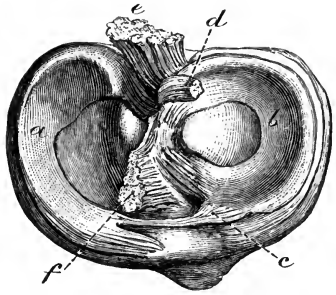


FIG. 84.—THE FIBRO-CARTILAGES OF THE KNEE-JOINT. VIEW OF THE HEAD OF THE TIBIA WITH THE FIBRO-CARTILAGES ATTACHED; THE CRUCIAL LIGAMENTS HAVE BEEN CUT THROUGH.

a. Inner, and *b*, outer semilunar fibro-cartilage.

e. Transverse, and *d*, ascending or posterior band (cut) of the external cartilage.

c. Posterior, and *f*, anterior crucial ligament.

Internal is oval.

The *internal fibro-cartilage* (*a*) is oval in form, and is less sharply curved than the external. In front it is attached by a pointed end close to the anterior margin of the head of the tibia, in front of the anterior crucial ligament. At the back, where it is much wider, it is fixed to the inner lip of the hollow behind the spine of the tibia, between the attachment of the other cartilage and the posterior crucial ligament.

External nearly circular in form:

The *external fibro-cartilage* (*b*) is nearly circular in form, and is connected to the bone within the points of attachment of its fellow. Its anterior part is fixed in front of the spine of the tibia, close to the outer articular surface, and opposite the anterior crucial ligament which it touches; and its posterior extremity is inserted behind and between the two osseous points of the spine. This fibro-cartilage is less closely united to the capsule than the internal, for the fore part is in the centre of the joint, and the tendon of the popliteus muscle separates it behind from that membrane.

The outer fibro-cartilage is provided with two accessory bands, one in front, the other behind.

its transverse and

The *anterior* or *transverse ligament* (*c*) is a narrow band of fibres between the semilunar cartilages at the front of the joint. Sometimes it is very small or even absent.

The *posterior* or *ascending band* (*d*), thicker and stronger than the other, springs from the back of the outer fibro-cartilage, and is inserted into the femur, either as a single band (fig. 83, *d*), when it is generally in front of the posterior crucial, or as two bands —one being before, and the other behind that ligament. posterior band.

Use. The fibro-cartilages deepen the sockets of the tibia for the reception of the condyles of the femur, and fill the interval between the articular surfaces of the bones at the circumference of the joint; they distribute the pressure of one bone on the other over a larger surface, and cause the force of shocks to be diminished in transmission. In flexion and extension they move forwards and backwards with the tibia over the femoral condyles. During flexion they recede somewhat from the fore part of the joint, and surround the narrow parts of the condyles; but in extension they are flattened out on the surface of the tibia. Of the two cartilages, the external moves the most in consequence of its being less attached to the capsule. Use of fibro-cartilages, in flexion and extension,

In rotation the fibro-cartilages follow the condyles of the femur, and glide over the tibial articular surfaces, the external moving more than the internal. and in rotation:

The accessory bands in front and behind serve to retain in place the less fixed external fibro-cartilage; thus the anterior ligament keeps forwards the front of that cartilage in flexion, and the posterior secures the back of the same from displacement in rotation. use of accessory bands.

Articular surfaces of the bones. The end of the femur is marked by a patellar and two tibial surfaces. Surfaces of bone.

The patellar is placed in the middle above the others; it is hollowed along the centre, with a slanting surface on each side, the outer being much the larger of the two. On femur, patellar

The surfaces for contact with the tibia, two in number, occupy the ends of the condyles, and are separated from the patellar impression by an oblique groove on each side. At the lower part of each is a somewhat flattened surface, which is in contact with the tibia in standing; while behind there is a more convex portion, which touches the tibia in flexion. and tibial: characters of tibial;

The inner condyle of the femur is curved in its anterior third, the concavity being directed outwards and backwards; this has been named the "oblique curvature." Along the concave margin of the curve is a semilunar facet, which touches the perpendicular surface of the patella in extreme flexion. peculiarities of inner.

On the head of the tibia are two slight articular hollows, the inner being the deeper and larger, which rise towards the middle of the bone, on the points of the tibial spine. Articular surfaces of tibia.

The joint-surface of the patella has the following marks. Close to the inner edge is a narrow perpendicular facet, and along the lower border is a similar transverse mark. Occupying the rest of the bone is a squarish surface, which is subdivided by a vertical and by two transverse lines into three pairs of facets—upper, middle, and lower. The transverse lines are fainter than the vertical. Subdivision of joint-surface of patella.

Movements of the joint. The chief movements of the knee are two Kinds of movement.

Interosseous membrane between the shafts:

The INTEROSSEOUS MEMBRANE fills the interval between the bones of the leg, and serves as an aponeurotic partition between the muscles on the front and back of the limb. Its fibres are directed for the most part downwards from the tibia to the fibula; but a few cross in the opposite direction.

attachments;

Internally it is fixed to the outer edge of the tibia; and externally, to the prominent interosseous ridge on the inner side of the fibula.

apertures.

In its upper part, close to the neck of the fibula, is an oval opening about an inch in length, which transmits the anterior tibial vessels; and at the lower end, between the membrane and the inferior articulation, is another small opening for the anterior peroneal vessels.

Motion slight,

Movement. Very little movement is allowed in the tibio-fibular articulations, as the chief use of the fibula is to give strength and elasticity to the ankle-joint, and attachment to muscles of the leg.

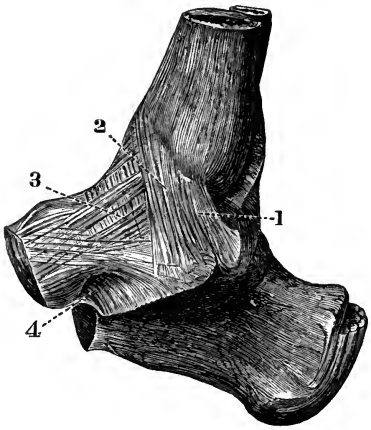


Fig. 85.—Inner Side of the Ankle (altered from Bourgery).

1. Posterior, 2, middle, and 3, anterior fibres of the inner lateral ligament.
4. Internal calcaneo-navicular ligament.

in upper, and lower articulation.

In the upper joint there is a slight gliding chiefly from within out. In the lower articulation the ligaments permit some yielding of the fibula to the pressure of the astragalus, as when the weight of the body is thrown on the inner side of the foot; but if the force is violent the fibula will be fractured about the junction of the third and lowest fourths sooner than the ligaments give way.

Articulation of the Ankle (figs. 85 and 86).

Bones in the ankle-joint.

The ankle is a hinge joint, in which the upper part of the astragalus is received into an arch formed by the lower ends of the tibia and fibula; and the four ligaments belonging to this kind of articulation connect together the bones.

Dissection of the ankle-joint.

Dissection. To make the dissection required for the ligaments of the ankle-joint, the muscles and the fibrous tissues and vessels must be removed from the front and back of the articulation.

For the purpose of defining the lateral ligaments, the limb must be placed first on one side and then on the other. The internal ligament is wide and strong, and lies beneath the tendon of the tibialis posticus. The external is divided into three separate pieces;

and to show these, the peronei muscles, and the remains of the annular ligament below the outer malleolus, should be taken away.

The *anterior ligament* is a thin fibrous membrane, which is attached to the tibia close to the articular surface, and to the upper part of the astragalus near the articulation with the navicular bone. In the ligament are some rounded intervals and apertures for vessels. On the sides it joins the lateral ligaments. Anterior ligament thin and imperfect.

The *posterior ligament* is thinner than the anterior, and is attached to the tibia and astragalus, close to the articular surfaces of the bones. Towards the outer side it consists of transverse fibres, which are fixed into the hollow on the inner side of the external malleolus. Posterior ligament.

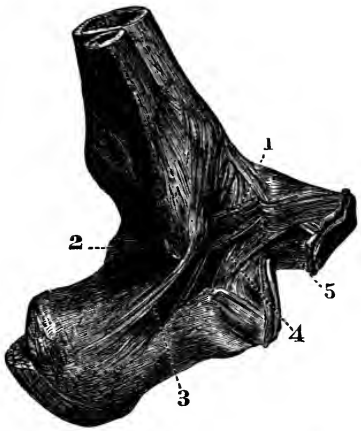


Fig. 86.—External Lateral Ligament of the Ankle (altered from Bourgery).

1. Anterior part, 2, posterior part, and 3, middle part of the outer ligament.
4. Interosseous of astragalus and os calcis.
5. External calcaneo-navicular ligament.

The *internal lateral* or *deltoid ligament* (fig. 85) is attached by its upper, smaller end to the inner malleolus, and by its base to the tarsal bones, by fibres which radiate to their insertion in this manner:—The posterior (1) are directed to the hinder part of the inner surface of the astragalus; the middle (2) pass vertically to the sustentaculum tali of the os calcis; and the anterior (3), which are thin and oblique, join the internal calcaneo-navicular ligament and the inner side of the navicular bone. The tendons of the tibialis posticus and flexor longus digitorum are in contact with this ligament. Internal or deltoid: attachments.

The *external lateral ligament* (fig. 86) consists of three separate pieces, anterior, middle, and posterior, which are attached to the astragalus and the os calcis. The *anterior* piece (1) is a short flat band, which is directed from the fore part of the malleolus to the side of the astragalus in front of the lateral articular surface. The *middle* portion (3) descends from the tip of the malleolus to the outer surface of the os calcis, about the middle. The *posterior* (2) is the strongest, and is almost horizontal in direction; it is fixed externally to the pit on the inner surface of the malleolus, and is inserted into the external tubercle and adjoining posterior part of the external surface of the astragalus behind the lateral articular facet. External has three pieces: anterior, middle, and posterior;

The posterior and middle fasciculi are placed beneath the peronei muscles. The middle piece is but slightly in contact above with the synovial membrane of the ankle-joint; and both it and the relations.

posterior part touch the synovial membrane between the astragalus and the os calcis.

Open the ankle-joint.

Dissection. Dividing the ligaments of the ankle-joint, separate the astragalus from the bones of the leg, to see the osseous surfaces entering into the joint.

Synovial sac.

The *synovial membrane* of the joint lines the capsule, and is simple in its arrangement; but the cavity is continued upwards for a short distance between the tibia and fibula.

Surfaces of the bones in the joint.

Articular surfaces. On the tibia there are two articular surfaces, one of which corresponds with the end of the shaft, and the other with the malleolus. On the fibula the surface of the malleolus which is turned to the astragalus is covered with cartilage.

The astragalus has an upper articular surface, wider before than behind and trochlea-shaped, which is in contact with the end of the tibia; and on its sides are articular impressions for contact with the malleoli, of which the outer is the larger.

Kinds of motion.

Movements. Only the movements of flexion and extension are permitted in the ankle, except slight lateral movement in half extension; in the former movement the toes are raised towards the fore part of the leg; and in the latter, they are pointed towards the ground.

Flexion: moving bone;

In *flexion* the astragalus moves backwards so as to project behind; and the motion is arrested by the wide anterior part of the astragalus being wedged in between the malleoli.

state of ligaments.

The posterior ligament is stretched over the projecting astragalus, and the posterior and middle pieces of the external lateral, and the posterior part of the internal lateral ligament, are made tense.

Extension: moving bone;

In *extension* the astragalus moves forwards over the end of the tibia, and projects anteriorly. A limit to the movement is imposed by the meeting of the astragalus with the tibia behind.

state of ligaments;

The lateral ligaments are partly made tight as in flexion, for instance, the anterior piece of the external, and the fore and middle portions of the internal.

slight lateral motion.

When the joint is half extended, so that the small hinder part of the astragalus is brought into the arch of the leg-bones, a slight movement of the foot inwards and outwards may sometimes be obtained; but if the foot is forcibly extended, the portions of the lateral ligaments attached to the astragalus prevent this lateral movement by their tightness.

Dissection for the joints of the foot.

Dissection. The joints of the foot will be demonstrated by removing from both the dorsum and the sole all the soft parts which have been examined. Between the different tarsal bones bands of ligament extend, which will be defined by removing the areolar tissue from the intervals between them (fig. 87).

It will be more advantageous for the student to clean all the ligaments before he proceeds to learn any, than to prepare only the bands of one articulation at a time.

Astragalus with os calcis by

ARTICULATION OF THE ASTRAGALUS AND OS CALCIS. These bones form two joints, and are kept together by a strong interosseous ligament; there are also thin bands on each side and behind.

The *posterior ligament* (fig. 87, *a*) consists of a few fibres between the bones, where they are grooved by the tendon of the flexor hallucis; the *internal ligament* is a small band passing from the internal tubercle of the astragalus to the sustentaculum tali; and the *external ligament* (*b*) is connected to the sides of the astragalus and os calcis, near the middle piece of the external lateral ligament of the ankle-joint. posterior, internal, external,

The *interosseous ligament* (fig. 87, *c*) consists of strong vertical and oblique fibres, which are attached above and below to the depressions on the opposed surfaces of the two bones. This band extends across between the bones, and its depth is greatest at the outer side. and interosseous ligaments.

In a subsequent stage of the dissection (p. 228) the articular Articular surfaces;

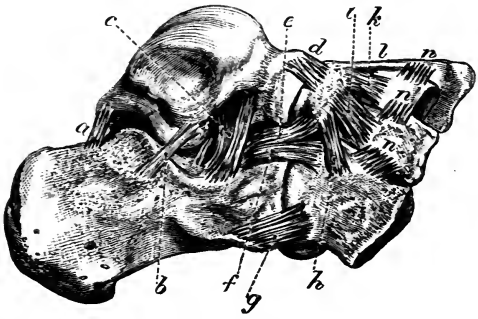


FIG. 87.—VIEW OF THE DORSAL LIGAMENTS OF THE TARSUS.

a. Posterior, *b*, external, and *c*, interosseous ligaments between astragalus and os calcis.
d. Astragalo-navicular.
e. External calcaneo-navicular.
f. Internal, and *g*, upper calcaneo-cuboid ligaments.
h. Dorsal naviculo-cuboid band.
i, *k*, *l*, Dorsal external, middle, and internal naviculo-cuneiform longitudinal bands.
n. Dorsal transverse bands between the cuneiform and cuboid bones.

surfaces of the bones will be seen, viz., one behind the interosseous ligament, and one in front of it, with two *synovial cavities*. synovial cavities.

Movements. It is between the astragalus and os calcis that the important movements of the foot known as inversion and eversion chiefly take place. The motion is one of rotation about an oblique axis, which is directed from the upper and inner part of the head of the astragalus, backwards, downwards, and outwards to the lower and outer part of the posterior extremity of the os calcis. Supposing the astragalus fixed between the malleoli, and the rest of the foot free to move, then in *inversion* the outer part of the os calcis moves forwards and downwards, and the sustentaculum tali in the opposite direction, while the anterior end of the bone is carried somewhat inwards. As a result of this, aided by corresponding movements of the anterior tarsal bones, the fore part of the foot is depressed, Movement between astragalus and os calcis: axis of motion. Inversion.

and the arch increased ; the toes are moved inwards ; and the outer border of the foot sinks, turning the sole in.

Eversion.

In *eversion* the above movements are reversed.

Condition of foot in standing ; effect of inversion.

In the ordinary mode of standing the foot is everted to the utmost, or nearly so, by the weight of the body ; if then inversion is practised, the inner side of the foot is raised from the ground, and the part is supported on its outer edge.

Astragalus with navicular bone:

ASTRAGALUS WITH THE NAVICULAR BONE. The head of the astragalus is received into the hollow of the navicular bone, and is united to it by a dorsal ligament ; but the place of plantar and lateral ligaments is supplied by strong bands between the os calcis and the navicular bone.

dorsal ligament.

The *astragalo-navicular ligament* (fig. 87, *d*) is attached to the astragalus close to the articulation, and to the dorsal surface of the navicular bone : its attachments will be better seen when it is cut through.

To lay bare the calcaneo-navicular ligaments.

Dissection. The external ligament of the articulation may be seen on the dorsum of the foot in the hollow between the os calcis and the navicular bone, and if the tendon of the tibialis posticus be removed, the internal ligament will be exposed, covering the head of the astragalus on the inner side and below.

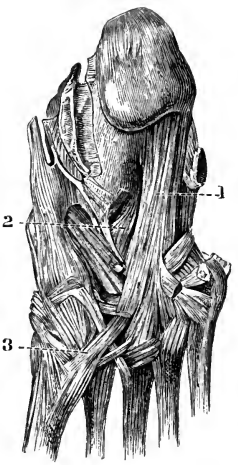


FIG. 88.—PLANTAR LIGAMENTS OF THE FOOT (BOURGERY).

1. Long plantar ligament.
2. Inner part of the short plantar ligament.
3. Tendon of the peroneus longus muscle.

Internal and

The *internal* or *inferior calcaneo-navicular ligament* (fig. 89, *c*, p. 227) is attached behind to the inner and fore parts of the sustentaculum tali of the os calcis, and in front to the inner extremity and lower border of the navicular bone. This ligament is partly fibro-cartilaginous ; its inner side is crossed by the tendon of the tibialis posticus muscle ; and its deep surface forms part of the socket for the head of the astragalus.

external ligament.

The *external calcaneo-navicular ligament* (fig. 87, *e*) is placed outside the head of the astragalus, and is about three-quarters of an inch deep. Behind, it is fixed to the upper part of the os calcis, between the articular surfaces for the cuboid bone and astragalus ; and in front it is inserted into the outer side of the navicular bone.

Synovial sac.

The *synovial cavity* of this articulation is continued backwards into the joint between the front of the os calcis and the astragalus.

Surfaces of bone.

Articular surfaces. The head of the astragalus has three convex articular surfaces, a large one in front, elongated transversely and broader externally than internally, for the navicular bone ; a narrow oblique surface below for the os calcis ; and a small intermediate

triangular facet internally for the internal calcaneo-navicular ligament. The surface of the navicular bone is hollowed, and is widest externally.

Movement. The navicular moves down and in over the head of the astragalus in inversion, or up and out in eversion. Movement:

As the bone is forced downwards, the upper and external ligaments of the joint are made tight; and when the navicular is moved in the opposite way, the strong internal ligament is put on the stretch. state of ligaments.

THE OS CALCIS WITH THE CUBOID BONE. The ligaments in this articulation are plantar, dorsal, and internal. Os calcis with cuboid bone, by

The *dorsal*, or *superior*, *calcaneo-cuboid ligament* (fig. 87, *g*) is a rather thin fasciculus of fibres, which is attached near to the contiguous ends of the os calcis and the cuboid bone; it is sometimes divided into two pieces, or it may be situate at the outer border of the foot. dorsal,

At the inner side of the cuboid bone is a variable *internal band* (fig. 87, *f*) from the os calcis; this is fixed behind to the upper part of the os calcis, outside the band to the navicular bone, and in front to the contiguous inner side of the cuboid. internal,

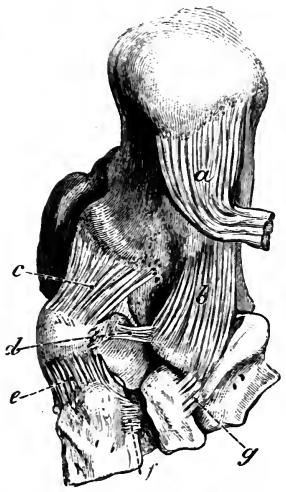


FIG. 89.—VIEW OF THE INFERIOR LIGAMENTS OF THE TARSAL BONES.

a. Long plantar cut.
b. Short or deep inferior calcaneo-cuboid ligament. and inferior ligaments.
c. Internal calcaneo-navicular.
d. Plantar transverse naviculo-cuboid ligament.
e. Dorsal inner naviculo-cuneiform extending into the sole of the foot. The last is strongest, and divided into two parts:
f. Plantar transverse ligament between the inner and middle cuneiform bones.
g. Plantar transverse band between the cuboid and outer cuneiform.

The *inferior calcaneo-cuboid ligament* is much the strongest, and is divided into superficial and deep parts:—

The superficial portion or *long plantar ligament* (fig. 88,[1]) is attached to the under-surface of the os calcis between the posterior and the anterior tubercles; its fibres pass forwards to be connected with the ridge on the under-surface of the cuboid bone; but the most internal are continued over the tendon of the peroneus longus muscle, assisting to form its sheath, and are inserted into the bases of the third and fourth metatarsal bones. superficial and

The deep piece or *short plantar ligament* (fig. 89, *b*), seen on division of the superficial (*a*), extends from the tubercle and the hollow on the fore part of the under-surface of the os calcis to the cuboid bone internal or posterior to the ridge. deep band.

The *synovial cavity* of the articulation is simple. Synovial sac.

Surfaces of bones. *Articular surfaces.* Both bones are flattened towards the outer part of the articulation; but at the inner side the os calcis is hollowed transversely, and the cuboid bone is convex to fit into it.

Movement: *Movement.* In this joint the cuboid bone may move in two directions, viz., obliquely down and in with inversion of the foot, and up and out with eversion.

state of ligaments. In the downward movement the internal lateral and the upper ligament are made tight; and in the upward, the calcaneo-cuboid ligaments of the sole are stretched.

Transverse tarsal articulation TRANSVERSE TARSAL ARTICULATION. This name is given to the line of articulation crossing the foot between the astragalus and os calcis behind and the navicular and cuboid bones in front: it will

includes two joints; be noticed, however, that it is not a continuous joint, but is composed of two separate articulations, viz., the astragalo-navicular and the calcaneo-cuboid.

movements; These joints participate, as has been already seen, in the movements of inversion and eversion, the anterior bones moving over the hinder ones, downwards and inwards in inversion, and upwards

amputation practised here. and outwards in eversion. It is at this line that the foot is divided in the operation known as Chopart's amputation.

Dissection. **Dissection.** Saw through the astragalus in front of the attachment of the interosseous ligament between it and the os calcis, and remove the head of the bone in order to see the disposition of the inner and outer calcaneo-navicular ligaments.

Then the interosseous ligament uniting the astragalus and the os calcis is to be cut through, to demonstrate its attachments, the articular surfaces of the bones, and the synovial sacs (p. 225).

Surfaces of os calcis *Articular surfaces* of the two hinder tarsal bones. There are two articular surfaces, anterior and posterior, to both the astragalus and the os calcis. The hinder one of the os calcis is convex from before back, and the anterior is concave; but sometimes the latter is

and astragalus. subdivided into two. The surface of the astragalus has a form exactly the reverse of that of the os calcis, viz., the hinder one concave and the anterior convex; the anterior is seated on the head of the astragalus.

Dissection. The calcaneo-cuboid joint may be opened to see the articular surfaces; and the student is to keep in mind that all the other articulations of the foot are to be opened for the like purpose, even should directions not be given.

Union of the navicular bone ARTICULATION OF THE NAVICULAR BONE. The navicular bone is united in front to the three cuneiform bones, and laterally to the cuboid.

to the cuneiform; In the *articulation with the cuneiform bones* (fig. 87) there are three longitudinal *dorsal ligaments* (*i*, *k*, *l*), one to each bone; but the innermost is the strongest and widest, and extends round the inside of the articulation into the sole of the foot (fig. 89, *e*).

The place of *plantar bands* is supplied by processes of the tendon of the tibialis posticus.

synovial sac: The naviculo-cuneiform articulations form one continuous joint,

and from their synovial cavity offsets are sent forwards between the cuneiform bones.

Between the navicular and cuboid bones there is an oblique *dorsal band* of fibres (fig. 87, *h*); a transverse *plantar band* (fig. 89, *d*), which is concealed by the tendon of the tibialis posticus; and a strong *interosseous ligament*. to the cuboid bone;

When the bones touch, the surfaces are tipped with cartilage, and a process of the naviculo-cuneiform synovial cavity extends between them. synovial sac.

ARTICULATION OF THE CUNEIFORM BONES. These bones are united to one another by cross bands; and the external one articulates with the cuboid after a similar manner. Union of the cuneiform bones

The three *cuneiform bones* are connected together by short transverse *dorsal bands* (fig. 87, *n*) between the upper surfaces, and *interosseous ligaments* between the rough parts of the contiguous sides of the bones. Laterally there are *articular surfaces* between the bones, with offsets of the common synovial cavity. one with another,

Where the external cuneiform touches the cuboid bone, the surfaces are covered with cartilage. A *dorsal ligament* (fig. 87, *n*) passes transversely between the two; and a *plantar ligament* (fig. 89, *g*) takes a similar direction. Between the bones there is also an *interosseous ligament*. and with the cuboid bone:

This joint is furnished either with a distinct synovial sac, or with a prolongation of the common synovial cavity. synovial sac.

The *synovial cavity* of the articulations of the cuneiform bones is common to many of the bones of the tarsus. Placed between the navicular and the three cuneiforms, it sends one prolongation forwards between the inner and middle cuneiform to the joints with the second and third metatarsal bones, another between the middle and outer cuneiform bones, a third outwards to the articulation of the navicular with the cuboid bone (when present), and sometimes a fourth to the joint between the external cuneiform and the cuboid. Common synovial sac.

Articular surfaces. On the navicular are three articular facets, the inner being rounded, and the other two flattened. The three cuneiforms unite in a shallow elliptical hollow, which is most excavated internally. Surfaces of bones.

Movement. The cuneiform bones glide up and out on the navicular in inversion of the foot, and down and in in eversion; and the inner one moves more than the others in consequence of the shape of the articular surfaces, and the attachment to it of the tibialis anticus. Motion in inversion and eversion;

When the bones pass down the dorsal ligaments are made tight: and as they rise the interosseous bands will keep them united. state of the ligaments,

In standing these bones are separated somewhat from each other with diminution of the arch of the foot, and stretching of the transverse ligaments which connect them. and joints in standing.

ARTICULATION OF THE METATARSAL BONES. The bases of the four outer metatarsal bones are connected together by dorsal, plantar, and interosseous ligaments; and where their lateral parts touch, they are covered with cartilage, and have offsets of a synovial sac. Union of the metatarsus by

The *dorsal ligaments* (fig. 90) are small transverse bands from dorsal,

plantar, and interosseous ligaments.

the base of one metatarsal bone to the next. The *plantar ligaments* (fig. 88) are similar to the dorsal. The *interosseous ligaments* are short transverse fibres between the contiguous rough lateral surfaces: they may be afterwards seen by forcibly separating the bones.

Lateral union:

Lateral union. The four outer bones touch one another laterally; the second metatarsal lies against the internal and external cuneiforms; and the fourth is in contact internally with the outer cuneiform. The articulating surfaces are covered with cartilage; and their synovial cavities are offsets of those serving for the articulation of the same four metatarsal with the tarsal bones.

synovial sacs.

Fig. 90.—Dorsal Ligaments uniting the Tarsus to the Metatarsus, and the Metatarsal Bones to each other behind (Bourgery).

Great toe separate.

The metatarsal bone of the great toe, like that of the thumb, is not united to the others at its base by any intervening bands.

Anterior ends.

The distal ends of the five metatarsal bones are united by the *transverse metatarsal ligament* (p. 210).

Tarsus and metatarsus

Tarsal with metatarsal bones. These articulations resemble the like parts in the hand, as there is a separate joint for the great toe, and a common one for the four outer metatarsals.

Joint of great toe

Articulation of the great toe. The articular ends of the bones are encased by a *capsule,* and are provided with an *upper* and a *lower longitudinal band* to give strength to the joint: the lower band is placed between the insertions of the tendons of the tibialis anticus and peroneus longus.

separate from rest:

synovial sac.

A simple *synovial sac* serves for the articulation.

Form of bones.

The *articular surfaces* are oval from above down, curved inwards, and constricted in the middle; that of the metatarsal bone is excavated, and the other is convex.

Motion up and down,

Movement. There is an oblique movement of the metatarsal bone down and in and up and out, like that of the internal cuneiform with the navicular bone; and this will contribute a little to inversion and eversion of the foot.

and lateral motion.

The joint possesses likewise slight abductory and adductory movement.

Joints of four outer toes:

Articulation of the four outer toes. The three outer tarsal bones of the distal row correspond with four metatarsals,—the middle cuneiform being opposite the second metatarsal bone, the external cuneiform touching the third, and the cuboid carrying the outer two bones. The surfaces in contact are tipped with cartilage, and have longitudinal dorsal, plantar, and lateral ligaments, with some oblique in the sole.

dorsal ligaments;

The *dorsal ligaments* (fig. 90) are thin bands of fibres, which are

more or less longitudinal as they extend from the tarsal to the metatarsal bones. The metatarsal bone of the second toe receives three ligaments, one coming from each cuneiform bone. The third bone obtains a ligament from the external cuneiform; and the fourth and fifth each have a fasciculus from the cuboid.

plantar ligaments;

Plantar ligaments (fig. 88). There is one *longitudinal band* from each of the outer two cuneiform to the corresponding metatarsal bone; but between the cuboid and its metatarsal bones there are only some scattered fibres.

lateral ligaments;

The *lateral ligaments* are longitudinal; they lie deeply between the bones, and are connected with the second and third metatarsals: they will be better seen by cutting the transverse bands joining the bases of the bones. To the bone of the second toe there are two bands, one on each side;—the inner is strong and is attached to the internal cuneiform; and the outer is fixed to the external cuneiform bone. The metatarsal bone of the third toe is provided with one lateral slip on its outer side, which is inserted behind into the external cuneiform bone.

oblique plantar.

Oblique plantar ligaments. A fasciculus of fibres extends across from the front of the internal cuneiform to the second and third metatarsals; and from the external cuneiform there is another slip to the metatarsal bone of the little toe.

Line of the articulation across the foot.

Line of the articulation. The line of the articulation between the tarsus and metatarsus is zigzag, in consequence of the unequal lengths of the cuneiform bones. To open the articulation, the knife should be carried obliquely forwards from the tuberosity of the fifth to the outer side of the second metatarsal bone; then about two lines farther back for the union of the second metatarsal with the middle cuneiform; and finally, half an inch in front of the last articulation, for the joint of the internal cuneiform with the first metatarsal bone.

Two synovial sacs.

Two *synovial cavities* are present in these tarso-metatarsal articulations.

There is one between the cuboid and the two outer metatarsals, which serves also for the adjacent lateral articular surfaces of the latter bones, but this is not always separate from the following one.

The second is placed in the joint between the external and middle cuneiforms with their metatarsal bones (third and second), and is an offset of the common synovial cavity belonging to the articulation of the navicular with the cuneiform bones (p. 229): prolongations from it extend between the lateral articular facets of the second, third, and fourth (inner side) metatarsals.

Form of the bones.

Articular surfaces. The osseous surfaces are not flat; for the metatarsal bones are undulating, and the tarsal are uneven to fit into the others.

Motion from above down,

Movement. From the wedge-shaped form of the metatarsal bones, only a slight movement from above down is obtainable; and this is greatest in the little toe and the next.

with abduction and adduction.

In the little toe there is an abductory and adductory motion; and a small degree of the same exists in the fourth toe.

Separate the bones to see interosseous ligaments.

Dissection. All the superficial ligaments having been taken away, the interosseous ligaments of the tarsus and metatarsus may be seen by separating forcibly the cuneiform bones from one another and from the cuboid, the latter bone from the navicular, and the bases of the metatarsals from one another. The dissector will find that, in using force, the bones will sometimes tear sooner than the ligaments.

Union of metatarsus and phalanges, by two lateral ligaments, and inferior: synovial sac.

METATARSUS WITH PHALANGES. These are condyloid joints, in which the head of the metatarsal bone is received into the cavity of the phalanx.

Each articulation has an *inferior* and two *lateral ligaments*, as in the hand; and the joint is further strengthened above by an expansion derived from the tendons of the extensors of the toes. A distinct *synovial sac* exists in each joint.

In the articulation of the great toe there are two sesamoid bones, which are connected with the inferior ligament.

All these structures are better seen in the hand, where they are more distinct; and their anatomy has been more fully described with the dissection of that part. (See pp. 104 and 105.)

Form of bones.

Surfaces of bone. The metatarsal bone has a rounded head, which is longest from above down, and reaches farthest on the plantar surface. On the end of the phalanx is a cup-shaped cavity.

Kind of motion.

Movement. In this condyloid joint, as in the hand, there is angular motion in four different directions, with circumduction.

Bending and extending,

Flexion and extension. When the joint is bent, the phalanx passes under the head of the metatarsal bone; and when it is extended, the phalanx moves back beyond a straight line with the metatarsal bone.

state of ligaments:

A limit to flexion is set by the meeting of the bones, by the stretching of the upper part of the lateral ligaments, and by the extensor tendon; and to extension, by the tightness of the inferior, and the lower part of each lateral ligament, and by the flexor tendons.

lateral motion:

Lateral movement. The phalanx passes from side to side across the end of the metatarsal bone. Its motion is checked by the lateral ligament of the side from which it moved, and by the contact with the other digits.

circular motion limited.

Circumduction, or the revolving of the phalanx over the rounded head of the metatarsal bone, is least impeded in the great toe joint; but these movements in the foot are not so free as in the hand.

ARTICULATIONS OF THE PHALANGES. There are two interphalangeal joints to each toe, except the first.

Union of the phalanges.

Ligaments similar to those in the metatarso-phalangeal joints, viz., two *lateral* and an *inferior*, are to be recognised in these articulations. The joint between the last two phalanges is least distinct; and oftentimes the small bones are immovably united by osseous substance. These ligaments receive a more particular notice with the dissection of the hand (p. 105).

Synovial sac.

A simple *synovial membrane* exists in each phalangeal articulation.

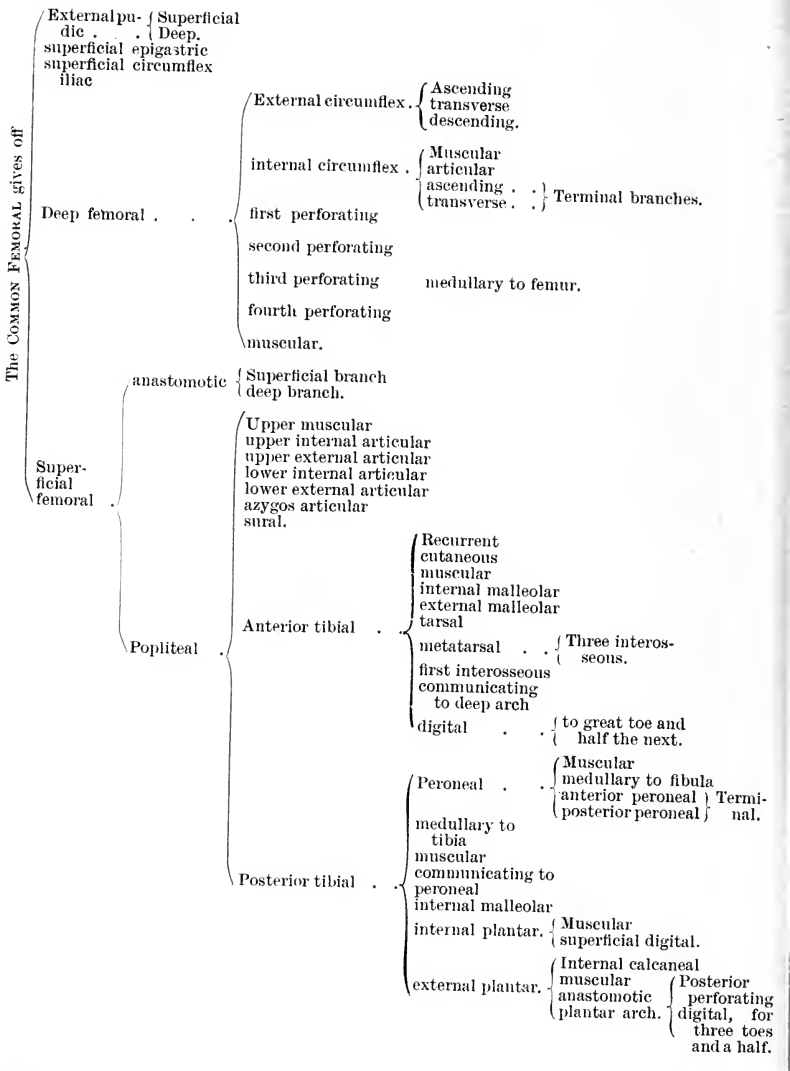
Articular surfaces. In both phalangeal joints, the nearer phalanx presents a trochlear surface; and the distal one is marked by two lateral hollows or cups with a median ridge. Form of bones.

Movement. Only flexion and extension are permitted in the two phalangeal joints of the toes, as in the hand. Kind of motion,

In *flexion* the farther phalanx glides under the nearer: and in *extension* the two are brought into a straight line. movement of bone,

The bending is checked by the lateral ligaments and the extensor tendon; and the straightening is limited by the inferior ligament and the flexor tendons. state of ligaments.

TABLE OF THE ARTERIES OF THE LOWER LIMB.


The Common Femoral gives off
External pudic . { Superficial / Deep.
superficial epigastric
superficial circumflex iliac
Deep femoral . .
External circumflex . { Ascending / transverse / descending.
internal circumflex . { Muscular / articular / ascending . . / transverse . . } Terminal branches.
first perforating
second perforating
third perforating
fourth perforating
muscular.
medullary to femur.
Superficial femoral .
anastomotic { Superficial branch / deep branch.
Popliteal .
Upper muscular
upper internal articular
upper external articular
lower internal articular
lower external articular
azygos articular
sural.
Anterior tibial . .
Recurrent
cutaneous
muscular
internal malleolar
external malleolar
tarsal
metatarsal . . { Three interosseous.
first interosseous communicating to deep arch
digital . . { to great toe and half the next.
Posterior tibial . .
Peroneal . . { Muscular / medullary to fibula / anterior peroneal / posterior peroneal } Terminal.
medullary to tibia
muscular
communicating to peroneal
internal malleolar
internal plantar. { Muscular / superficial digital.
external plantar. { Internal calcaneal / muscular / anastomotic / plantar arch. { Posterior perforating digital, for three toes and a half.

N.B. The branches of the internal iliac artery which end in the limb will be found in the Table of the Arteries of the Abdomen.

TABLE OF THE NERVES OF THE LOWER LIMB.

Nerves of the Lumbar Plexus in the Limb.

1. Iliac branch of ilio-hypogastric.
2. Ilio-inguinal.
3. Crural branch of genito-crural.
4. External cutaneous.
5. Obturator
   - Accessory . . To obturator trunk; to pectineus; to hip-joint.
   - superficial division
     - Articular . . To hip joint.
     - muscular . . To gracilis; to adductor longus; to adductor brevis.
     - to plexus in the thigh and artery; to skin sometimes.
   - deep division
     - Muscular . . To obturator externus; to adductor magnus; to adductor brevis.
     - articular . . To knee-joint.
6. Anterior crural
   - Superficial portion
     - Muscular . . To sartorius; to pectineus
     - middle cutaneous; internal cutaneous . . Anterior and posterior branches.
   - deep portion
     - Muscular . . To rectus—articular; to vastus externus—articular; to vastus internus and crureus—articular.
     - internal saphenous . . Branch to plexus over patella; to leg and foot.

Nerves of the Sacral Plexus in the Limb.

1. Superior gluteal — To gluteus medius and minimus; to tensor fasciæ femoris.
2. Inferior gluteal — To gluteus maximus.
3. Small sciatic — Inferior pudendal; cutaneous to gluteal region, thigh, and leg.
4. Great sciatic
   - Muscular . . To hamstrings; to adductor magnus.
   - external popliteal
     - Articular; external cutaneous of leg; peroneal communicating; recurrent articular
     - musculo-cutaneous . . To peronei; cutaneous to foot and toes.
     - anterior tibial . . Muscular; anticular; cutaneous to two toes,
   - internal popliteal
     - Articular; muscular . . To calf-muscles and popliteus.
     - tibial communicating
     - posterior tibial
       - Muscular . . To soleus, long flexors of toes, and tibialis posticus.
       - calcaneo-plantar
       - internal plantar . . Cutaneous muscular; four digital communicating branch.
       - external plantar
         - superficial part . . Muscular
         - deep part . . Cutaneous two digital communicating; Muscular.
5. To obturator internus and superior gemellus.
6. To quadratus femoris and inferior gemellus.
7. Perforating cutaneous.

CHAPTER V.

DISSECTION OF THE PERINEUM.

SECTION I.

PERINEUM OF THE MALE.

Before the dissection pass catheter.

Directions. The perineum is allotted to the dissector of the abdomen, and its examination is made during the first three days that the body is in the dissecting-room. Before the body is placed in the position suited for the dissection, the student should practise passing the catheter along the urethra.

Place the body in position.

Position of the body. For the dissection of the perineum the body is fixed in the following manner :—While it lies on the back it is drawn down to the end of the dissecting table till the buttocks project slightly over the edge, and a block is placed beneath the

and fasten upwards the legs.

pelvis to raise the perineum to a convenient height. The knees having been bent, the thighs are to be raised upon the trunk, and the limbs fastened with a cord in their bent position. For this purpose make one or two turns with the cord round one bent knee (say the right), carry the cord beneath the table, and, encircling the opposite limb in the same manner, fasten it finally round the right knee.

Pass a staff.

Further directions. When the position has been arranged, the student, standing on the left side of the body, should pass a well-oiled staff into the bladder. This should be done by holding the penis with the left hand and guiding the staff with the right. When the point of the instrument passes below the pubic arch a resistance will be felt which is caused by the triangular ligament. The staff, with the head kept square and in the middle line, should then be depressed and passed on, but without force. If necessary, the student may guide the point through the urethra under the pubic arch by the left forefinger passed into the rectum. The staff should now be fixed in position, with the point in the bladder, by tieing the handle firmly over the front of the lower part of the abdomen to the cords on either

Stitch up the scrotum

side of the body. The scrotum should be drawn well up away from the perineum and fastened to the staff above the penis by a stitch passed through its extremity and tied round the staff. A small quantity of tow should then be passed into the rectum, but not so as to distend it, and the anus neatly stitched up.

The surface limits.

Superficial limits and marking. The perineal space in the male is

limited, on the surface of the body, by the scrotum in front, and by the thighs and buttocks on the sides and behind.

The anus.

The skin of this region is of a dark colour, and is covered with hairs. In the middle line is the aperture of the anus, which is behind a line extending from the anterior part of the one ischial tuberosity to the other. In front of the anus the surface is slightly convex over the urethra, and presents a longitudinal prominent line or *raphé*, which divides the space into halves. Between the anus and the tuberosity of the hip-bone the surface is somewhat depressed over the hollow of the subjacent ischio-rectal fossa, especially in emaciated bodies.

the raphé.

hollow on side of anus,

and folds and veins around that opening.

The margin of the anal aperture possesses numerous converging folds, but these are more or less obliterated by the position of the body and the distention of the anus; and projecting oftentimes through and around the opening are some dilated veins (hæmorrhoids).

Bounding parts same as those of outlet of pelvis.

Deep boundaries. The deep boundaries of the perineal space will be ascertained, in the progress of the dissection, to correspond with the inferior aperture or outlet of the pelvis. The limits are to be observed on a dry or prepared pelvis, on which the ligaments remain entire; and the student should trace on the body the corresponding boundaries with his finger. In front is the symphysis pubis; and at the back is the tip of the coccyx, with the great gluteal muscles. On each side in front is the portion of the hip-bone which bounds the subpubic arch, viz., from the pubic symphysis to the ischial tuberosity; and further back is the great sacro-sciatic ligament extending from the tuberosity to the coccyx. This region sinks into the outlet of the pelvis as far as the recto-vesical fascia, which forms its floor.

Form of the space, and measurements.

Form and size. The interval included within the boundaries above described is rather heart-shaped, owing to the projection of the coccyx behind; and it measures over the surface about four inches from before backwards, and three and a half inches between the ischial tuberosities.

Depth of the space.

Depth. The depth of the perineum from the surface to the floor, which will be revealed in dissection, may be said to be generally about three inches between the anus and the ischial tuberosity, but this measurement varies greatly in different bodies; and it amounts to about an inch at the fore part, between the pubic bones.

A line between the tuberosities divides it into two.

Division. A line from the front of the tuberosity of one side to the corresponding point on the other will divide the perineal space into two parts. The anterior half (*urethral*) contains the root of the penis and the urethra, with their muscles, and vessels and nerves. The posterior half (*rectal*) is occupied by the lower end of the large intestine, with its muscles, &c.

POSTERIOR HALF OF THE SPACE.

Contents of anal half,

This portion of the perineal space contains the lower end of the rectum, surrounded by its elevator muscles and the muscles acting

and their general position.

on the anus. The gut does not occupy, however, the whole of the interval between the pelvic bones ; for on each side is a space, the *ischio-rectal* fossa, in which is contained much loose fat, with the vessels and nerves for the supply of the end of the gut.

Dissection

Dissection (fig. 91, p. 239 and fig. 92, p. 241). The workers on the two sides should dissect in conjunction displaying the muscles on the one side and the nerves and vessels on the other. The skin is to be raised from this part of the perineum by the following cuts :—*One* is to be made across the perineum at the front of the anus, and is to extend rather beyond the ischial tuberosity on each side. A *second* is to be carried across in the same direction a little behind the tip of the coccyx, and for the same distance. The two transverse cuts are to be connected by carrying the knife along the mid-line, and around the anus. The flaps of the skin thus marked out are to be raised and thrown outwards from the middle line : in detaching the skin from the margin of the anus, the superficial fibres of the sphincter muscle may be injured if care be not taken, for they are close to the skin without the intervention of fat. The dissector should trace the external sphincter backwards to the coccyx, and forwards for a short distance beneath the skin, and define a fleshy slip on each side in front and behind to the subcutaneous fatty layer.

of external sphincter muscle.

Difference in cleaning the ischio-rectal fossæ.

The next step is to bring into view the ischio-rectal hollow between the side of the rectum and the tuberosity of the hip-bone. *On the left side* the fat is to be cleaned out of it without reference to the vessels and nerves, but on the opposite side a special dissection is to be made of them (fig. 92). To take out the fat from the left fossa, begin at the outer margin of the sphincter ani, and proceed forwards and backwards. In front the dissection should not extend farther than a finger's breadth in front of the anus, while behind it should lay bare the margin of the gluteus maximus. On the inner side of the hollow the levator ani (sometimes very pale) is to be exposed by the removal of a thin layer of areolar tissue (anal fascia). On the outer boundary the pudic vessels and the accompanying nerves should be denuded : they lie in a canal formed by fascia, and at some distance from the surface.

Dissection of left ischio-rectal fossa.

On right side, seek vessels and nerves.

On the right side it is not necessary to clean the muscular fibres when following the vessels and nerves. If the student begins at the outer border of the sphincter, he will find the inferior hæmorrhoidal vessels and nerve, which he may trace outwards to the pudic trunks ; some of the branches, which join the superficial perineal and inferior pudendal nerves, are to be followed forwards. In the posterior angle of the space seek a small offset of the fourth sacral nerve ; and external to it, branches of the perforating cutaneous nerve from the sacral plexus, with small vessels, turning round the border of the gluteus. Near the front of the fossa is the superficial perineal artery with a nerve ; and the last, after communicating with the hæmorrhoidal nerve, leaves the fossa. A second perineal nerve, with a deeper position, may be found at the front of the hollow.

Situation ;

The ISCHIO-RECTAL FOSSA (fig. 91) is the interval between the

rectum and the ischial part of the hip-bone. It is a somewhat pyramidal hollow, which is larger behind than before, and diminishes in width as it sinks on the inner side of the hip-bone. Its width is about one inch at the surface ; and its depth about two inches at the outer side. It is filled by a soft granular fat. form ; dimensions

The inner or longest side of the space is very oblique, and is formed by the levator ani muscle (D), together with the coccygeus at the back ; but the outer side is vertical, and is formed by the obturator boundaries.

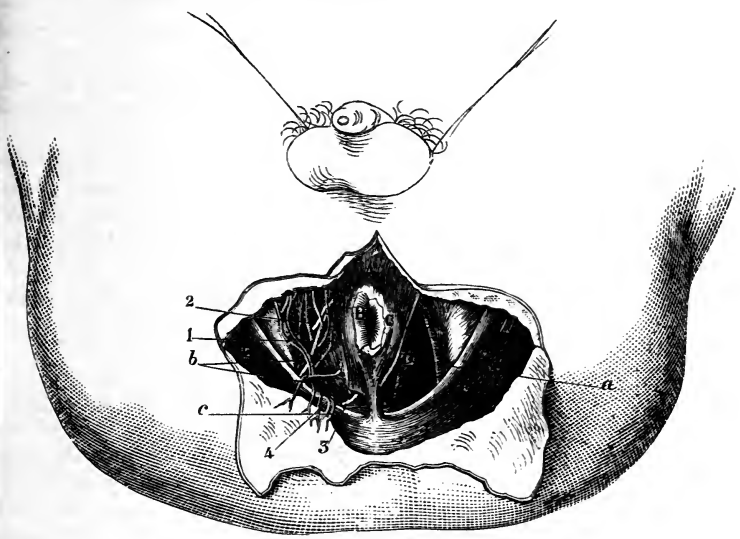


FIG. 91.—THE RECTAL HALF OF THE PERINEUM (ILLUSTRATIONS OF DISSECTIONS).

Muscles :
A. External sphincter.
B. Corrugator cutis, only part left.
C. Internal sphincter.
D. Levator ani.
E. Gluteus maximus.

Arteries :
a. Trunk of the pudic artery.
b. Inferior hæmorrhoidal, and *c*, its gluteal branches.

Nerves :
1. Inferior hæmorrhoidal.
2. Superficial perineal.
3. Perineal branch of the fourth sacral.
4. Perforating cutaneous.

internus muscle and the fascia covering it. In front it is limited by the triangular ligament (to be afterwards seen) ; and behind are the great sacro-sciatic ligament, and the gluteus maximus muscle. Towards the surface it is covered by the teguments, and is overlain in part by the gluteus (E) and the sphincter externus (A).

Vessels and nerves in the space. Along the outer wall, contained in a sheath of fascia, lie the pudic vessels (*a*) and the perineal and dorsal divisions of the pudic nerve ; opposite the ischial tuberosity they are situate about an inch and a half below the surface of the bone, but towards the front of the space they approach to within Pudic vessels on the outer wall

half an inch of the margin of the ischial ramus. Crossing the centre of the hollow are the inferior hæmorrhoidal vessels and nerve (*b*),—branches of the pudic. At the anterior part, for a short distance, are two superficial perineal nerves (2) (of the pudic); and at the posterior part is a small branch of the fourth sacral nerve (3), with cutaneous offsets of the sacral plexus (4) and inferior hæmorrhoidal vessels (*c*), bending round the gluteus.

and nerves in the space.

First cut in lithotomy enters this space.

The surgeon sinks his knife into this space in the first incision in the operation of lateral lithotomy: and as he carries it from before backwards, he will divide the superficial hæmorrhoidal vessel and nerve.

Muscles of rectum.

MUSCLES. Connected with the lower end of the rectum are four muscles, viz., a fine cutaneous muscle, and two sphincters (external and internal), with the levator ani.

Corrugator cutis ani: attachments;

CORRUGATOR CUTIS ANI (fig. 91, B). This thin subcutaneous layer of involuntary muscle surrounds the anus with radiating fibres. Externally it blends with the subdermic tissue outside the internal sphincter; and internally it enters the anus and ends in the submucous tissue within the sphincter.

use.

Action. This muscle draws upwards and inverts the mucous membrane of the lower end of the gut, after it has been protruded and everted in the passage of the fæces.

Superficial sphincter;

The EXTERNAL SPHINCTER (sphincter ani externus; fig. 91 A and fig. 92) is a flat, orbicular muscle, which surrounds the anal opening.

origin;

It *arises* posteriorly by a fibrous band from the back of the coccyx near the tip, and by fleshy fibres on each side from the subcutaneous fatty layer.

insertion;

Its fibres pass forwards to the anus, where they separate to encircle that aperture; and they are *inserted* in front into the central point of the perineum, and into the superficial fascia by a fleshy slip on each side.

relations;

The sphincter is close beneath the skin, and partly conceals the levator ani. The outer border projects over the ischio-rectal fossa; and the inner is contiguous to the internal sphincter.

and use.

Action. The muscle gathers into a roll the skin around the anus, and occludes the anal aperture. Commonly the fibres are in a state of involuntary slight contraction, but they may be firmly contracted under the influence of the will.

Deep sphincter, a pale band,

The INTERNAL SPHINCTER (sphincter ani internus; fig. 91, C) is situate round the extremity of the intestine, internal to the preceding muscle, and its edge will be seen by removing the corrugator muscle and the mucous membrane.

is part of fibres of intestine;

The fibres of the muscle are pale, fine in texture, quite separate from the surrounding external sphincter, and encircle the anus in the form of a ring about half an inch in depth. The muscle is a thickened band of the involuntary circular fibres of the large intestine, and is not attached to the bone.

use.

Action. This sphincter assists the external in closing the anus; and its contraction is altogether involuntary.

Insertion of levator ani

The LEVATOR ANI (fig. 91, D and fig. 92) can be seen only in part; and the external sphincter may be detached from the coccyx, in

order that its insertion may be more apparent. The muscle descends from its origin at the inner aspect of the hip-bone, and is *inserted* along the middle line from the coccyx to the central point of the perineum. The hindmost fibres are attached to the side of the coccyx; and between that bone and the rectum the muscles of opposite sides are united in a median tendinous line. The middle

into coccyx and tendon in front of it;

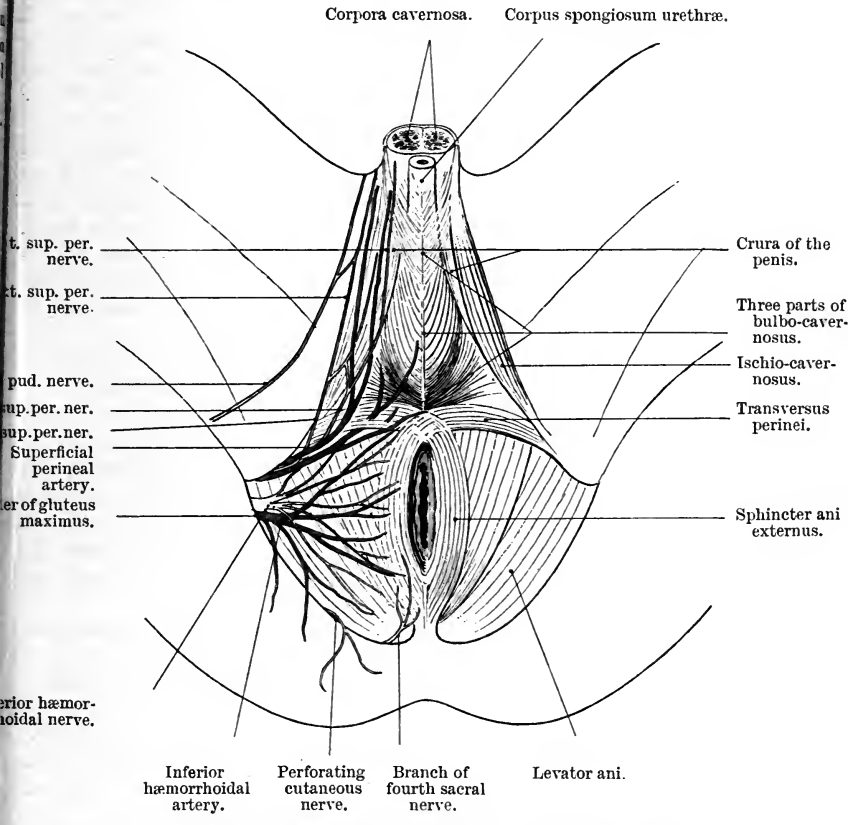


FIG. 92.—DIAGRAM OF THE MUSCLES, NERVES AND ARTERIES OF THE MALE PERINEUM.

fibres are blended with the side of the rectum. And the anterior are joined with the opposite muscle, in front of the rectum, in the central point of the perineum; except that some of them will be found to be prolonged backwards over the plane of the posterior fibres to the tip of the coccyx.

into rectum, and the centre of the perineum: relations;

This muscle bounds the ischio-rectal fossa on the inner side, and unites with its fellow to form a fleshy layer (pelvic diaphragm), convex downwards, through which the rectum is transmitted. On the

pelvic aspect of the muscle is the recto-vesical fascia. Along the hinder border is placed the coccygeus.

use on rectum. *Action.* It compresses the lower part of the rectum during the act of defæcation.

This muscle will be more fully seen and examined in the dissection of the pelvis (p. 382).

Arteries of the space. ARTERIES (fig. 92). The pudic artery, with its inferior hæmorrhoidal branch, and other small offsets of it, are now visible.

Pudic artery: The INTERNAL PUDIC ARTERY is derived from the internal iliac in the pelvis, and in its course to the genital organs distributes

course; offsets to the perineum; one portion will be laid bare in the posterior, and the other in the anterior half of the perineum.

posterior part in fossa; As now seen, the vessel enters the hinder part of the ischio-rectal fossa, and courses forwards along the outer wall at the depth of one

depth and relations. inch and a half at the back, but of only half an inch in front. It is contained in an aponeurotic sheath formed by the obturator fascia. The usual companion veins lie by its side; and two nerves accompany it, viz., the dorsal nerve of the penis, which is above it, and the

Branches:— perineal branch of the pudic nerve which is nearer the surface. Its offsets in this part of its course are the following:—

Inferior hæmorrhoidal. The *inferior hæmorrhoidal branch* arises as the artery enters the ischio-rectal fossa, and is directed inwards across the space to the anus, dividing into branches which supply the skin and fat, the levator ani and sphincter muscles, and the lower end of the rectum. On the gut it anastomoses with the other hæmorrhoidal arteries. In a well-injected body cutaneous branches may be seen to run forwards to the anterior part of the perineum, and to communicate with the superficial perineal artery. Other offsets turn upwards round the edge of the gluteus maximus to the integument of the lower and inner part of the buttock.

Muscular offsets. Small *muscular branches* cross the front of the ischio-rectal fossa, and supply the anterior part of the levator ani muscle.

Veins. *Veins* accompany the arteries, and have a like course and ramification: the pudic veins end in the internal iliac.

Nerves of the space. NERVES (figs. 91 and 92). The nerves seen at this stage of the dissection are the three divisions of the pudic trunk, a branch of the fourth sacral nerve, and the perforating cutaneous offset of the sacral plexus.

Pudic nerve divides into three parts: The PUDIC NERVE is derived from the sacral plexus, and lies over the small sacro-sciatic ligament with the artery in the buttock. In the small sacro-sciatic foramen the nerve breaks up into the three following branches, which enter the perineum:—

inferior hæmorrhoidal; The *inferior hæmorrhoidal branch* crosses the ischio-rectal fossa, and reaches the margin of the anus, where it terminates in offsets to the integument and the sphincter muscle. Other cutaneous offsets of the nerve run forwards over the fossa, and communicate with one of the superficial perineal nerves, and with the inferior pudendal (of the small sciatic) on the margin of the thigh.

perineal; The *perineal branch* is the largest of the three divisions, and runs

forwards in a sheath of the obturator fascia, lying below the pudic vessels. At the fore part of the ischio-rectal fossa it divides into cutaneous, muscular, and genital offsets. Its two cutaneous branches (superficial perineal) may be seen on the right side, where they lie for a short distance in the fat of the hollow.

The *dorsal nerve of the penis* accompanies the pudic artery along the outer side of the ischio-rectal fossa to the fore part of the perineum. It is also enclosed in the obturator fascia, but is deeper than the blood-vessels. and dorsal nerve of the penis.

The PERINEAL BRANCH OF THE FOURTH SACRAL NERVE reaches the ischio-rectal fossa between the levator ani and coccygeus, or by piercing one of these muscles, near the coccyx, and ends by supplying the external sphincter. Offset of fourth sacral nerve.

The PERFORATING CUTANEOUS NERVE is an offset from the lowest part of the sacral plexus, and is named from its piercing the great sacro-sciatic ligament in its course to the perineum. Turning upwards round the lower edge of the gluteus maximus, its branches are distributed to the skin of the inner and lower part of the gluteal region. Perforating cutaneous nerve.

ANTERIOR HALF OF THE PERINEAL SPACE.

In the anterior part of the perineal space are lodged the crura of the penis, and the tube of the urethra as it courses from the interior of the pelvis to the surface of the body. Placed midway between the bones, the urethra is supported by the triangular ligament of the perineum, and by its union with the penis. Urethral half: contents and general position of parts.

Muscles are collected around the urethra and the crura of the penis: most of these are superficial to, but one is within the triangular ligament.

The vessels and nerves lie along the outer side, as in the posterior half, and send offsets inwards.

Dissection (figs. 92 and 93). To raise the skin from the anterior half of the perineum, a transverse cut is to be made at the back of the scrotum, and is to be continued for a short distance (two inches) on each thigh. A second incision along the middle line from the one already made will allow the flap of skin to be reflected outwards. Incisions to raise the skin.

After the removal of the skin, the superficial fascia which covers the front of the perineal space should be blown up by means of a pipe attached to an ordinary cycle inflating pump or a pair of bellows, introduced beneath it posteriorly. Each side should be gently inflated separately to demonstrate the fact that there is a partition along the middle line. It will be seen that the air does not pass from the perineal space into the thigh, showing that the fascia is attached to the bony margins of the space. Blow up superficial fascia, and reflect it.

The student is next to cut through the superficial fascia on the left side of the scrotum to the ischio-rectal fossa; and after reflecting it, and removing loose fatty tissue, its line of attachment to the bone externally, and to the triangular ligament posteriorly, will be brought into view. The septum along the middle line should be also defined.

Define partition between thigh and perineal space.

To show more completely the attachment of this layer to the hip-bone between the perineal space and the thigh, it will be necessary to take away from the left limb the fat on the fascia lata, external to the margin of the bone.

On right side seek inferior pudendal nerve.

In the fat of the thigh on the right side the student should seek the inferior or long pudendal nerve (fig. 92), which pierces the fascia lata one inch in front of the ischial tuberosity, and about the same distance from the margin of the bone ; and he should trace its junction in the fat with the inferior hæmorrhoidal nerve. Afterwards the nerve is to be followed forwards to where it passes beneath the superficial fascia nearer the middle line.

Superficial fascia:

The *superficial fascia* of the anterior half of the perineum is composed of two layers, which differ in their characters and relations.

subcutaneous part;

One is the subcutaneous fatty part, continuous with that of the adjoining regions : its thickness, and the quantity of fat in it vary with the condition of the body. Passing in front into the scrotum, it there loses its fat, and contains involuntary muscular fibres, forming the layer known as the *tunica dartos*.

and membranous layer.

The other layer (fascia of Colles, and beneath which the air was injected) is a more membranous stratum of limited extent, and is connected with the firm subjacent structures. Externally it is fixed to the conjoined rami of the ischium and pubis, outside the line of the crus penis and its muscle, extending as far back as the ischial tuberosity. Posteriorly this layer bends upwards to join the triangular ligament of the urethra; but in front it is unattached, and is continued to the scrotum and penis. By means of the connections of the membrane on both sides, a space is enclosed over the anterior half of the perineum. From its deep surface a septum extends upwards in the middle line, and divides posteriorly the subjacent space into two: but anteriorly this partition is less perfect, or may disappear.

The latter forms a pouch, open in front; and divided by a septum.

Course of air and effused urine.

Air blown beneath the fascia passes forwards to the scrotum; which is the only possible direction owing to the deep connections of the membrane with parts around. Should urine be effused beneath the superficial fascia, the fluid will be directed forwards, like the air, through the scrotum to the penis and the front of the abdomen.

Dissection of nerves and vessels on right side.

Dissection. The superficial vessels and nerves are to be dissected on the right side of the perineum, by cutting through the superficial fascia in the same manner as on the left side. The long slender artery then visible is the superficial perineal, which gives a transverse branch near its commencement. Two superficial perineal nerves accompany the artery; and the inferior pudendal nerve is to be traced forward to the scrotum. Communications are to be sought between these nerves anteriorly, and between one of the perineal and the inferior hæmorrhoidal posteriorly ; and all the nerves are to be followed backwards (figs. 92 and 93).

Superficial vessels of pudic.

ARTERIES (figs. 92 and 93). The superficial and transverse perineal arteries beneath the fascia are branches of the pudic, and are two or three in number.

THE SUPERFICIAL PERINEAL ARTERY, arising at the fore part of the ischio-rectal fossa, runs over or under the transverse muscle, and beneath the superficial fascia, to the back of the scrotum, where it ends in flexuous branches. In its course through the perineum the vessel supplies offsets to the muscles beneath; and in the scrotum it anastomoses with the external pudic branches of the femoral artery. Sometimes there is a second perineal branch. Superficial perineal ends in scrotum, and supplies muscles.

The TRANSVERSE ARTERY OF THE PERINEUM arises from the preceding, and is directed transversely to the middle of the perineal Transverse artery.

FIG. 93.—THE ANTERIOR HALF OF THE PERINEUM (ILLUSTRATIONS OF DISSECTIONS).

Muscles, &c.:

A. Ejaculator urinæ.
B. Erector penis.
C. Transversus perinei.
D. Levator ani.
E. Gluteus maximus.
G. Crus penis.
H. Urethra.

Arteries:

a. Transverse perineal.
b. Superficial perineal.

Nerves:

1. Inferior hæmorrhoidal.
2 and 3. Superficial perineal.
4. Inferior pudendal.

space, where it is distributed to the integuments and the muscles between the urethra and the rectum. It anastomoses with the one of the opposite side.

Branches of *veins* accompany the arteries, and open into the trunk of the pudic vein; those with the superficial perineal artery are plexiform at the scrotum. Veins with the arteries.

NERVES (figs. 92 and 93). Three nerves run forwards to the scrotum on each side, viz., the inferior pudendal of the small sciatic, and two superficial perineal branches of the pudic nerve. Cutaneous nerves of scrotum.

Two superficial perineal;

THE SUPERFICIAL PERINEAL NERVES, two in number, are named external and internal: both arise in the ischio-rectal fossa from the perineal division of the pudic nerve (p. 242).

external

The *external branch* is continued forwards, beneath the superficial fascia, with the artery of the same name to the back of the scrotum. While in the fossa the nerve gives inwards an offset to the integuments in front of the anus; and this communicates with the inferior hæmorrhoidal nerve.

and internal;

The *internal branch* passes under the transverse muscle, and accompanies the other to the scrotum.

distributed to scrotum and penis.

The superficial perineal branches communicate with one another, and the external is joined by the inferior pudendal nerve. At the scrotum they are distributed by long slender filaments, which reach as far as the under surface of the penis.

Muscular branches.

Other *muscular branches* of the perineal nerve will be afterwards examined (p. 248).

Inferior pudendal nerve

The INFERIOR OR LONG PUDENDAL NERVE is a branch of the small sciatic. It pierces the fascia lata about one inch in front of the ischial tuberosity, and enters beneath the superficial fascia of the perineum, to end in the outer and fore parts of the scrotum.

ends in scrotum.

Communications take place between this nerve, the inferior hæmorrhoidal, and the outer of the two superficial perineal branches.

Dissection of muscles of the urethra and penis,

Dissection. For the display of the muscles, the superficial fascia, as well as the vessels and nerves of the left side, must be taken away from the anterior half of the perineal space. Afterwards a thin aponeurotic layer is to be removed from the surface of the muscles. Over the middle line lies the ejaculator urinæ, or *bulbo-cavernosus*; along the outer edge of the space is the erector penis, or *ischio-cavernosus*; and behind, passing obliquely between the other two, is the transverse muscle.

and of their nerves.

On the right side the student should seek the branches of the perineal nerve to the muscles.

Three muscles over triangular ligament.

MUSCLES (figs. 92 and 93). Superficial to the triangular ligament, in the anterior half of the perineal space, are the three muscles, viz., the erector penis, the ejaculator urinæ, and the transversus perinei. Another muscle of the urethra is contained between the layers of the triangular ligament, and will be subsequently seen.

Central point,

Central point of the perineum. Between the urethra and the rectum is a small transverse tendinous septum, to the centre of which this name has been applied. It is placed about one inch in front of the anus, and in it the muscles acting on the rectum and urethra are united. Its development varies greatly in different bodies.

where muscles join.

Erector penis:

origin;

insertion:

The ERECTOR PENIS (ischio-cavernosus) is the most external of the three muscles, and is narrower at each end than in the middle. It covers the crus penis: and its fibres *arise* from the ischial tuberosity farther back than the attachment of the penis, and from the bone on each side of the crus (p. 251). In front, the muscle is *inserted* into an

aponeurosis over the inner and outer surfaces of the crus penis. It rests on the root of the penis and the bone.

Action. The muscle compresses the crus penis against the subjacent bone, and retards the escape of the blood from the corpus cavernosum by the veins, and in that way it contributes to the erection of the organ. use

The EJACULATOR URINÆ (bulbo-cavernosus) lies on the urethra. The muscles of opposite sides *arise* from a median tendinous raphe for 2½ inches along the middle line, and from the central point of the perineum. The fibres are directed outwards, curving round the convexity of the urethra, and give rise to a thin muscle, which has the following *insertion* :—The *hindmost* fibres end on the lower surface of the triangular ligament. The *anterior* fibres, which are the longest and best marked, are inserted into the penis on its outer aspect, in front of the erector and send a tendinous expansion over the dorsal vessels of the penis. The *intervening* fibres, forming the greater part of the muscle, turn round the urethra, surrounding it for two inches, and join their fellows in a common tendon (fig. 92, p. 241). Ejaculator urinæ : origin at middle line insertion by three parts ;

The ejaculator muscle covers the bulb and the corpus spongiosum for nearly three inches below and in front of the triangular ligament. If the muscle be cut through on the left side and turned off the urethra, the junction with its fellow above the tube will be apparent. surrounds the urethra ;

Action. The two halves, acting as one muscle, can compress the urethra, and forcibly eject its contents. During the flow of fluid in micturition the fibres are relaxed, but they come into use at the end of the process, when the passage has to be cleared. The action is involuntary in the emission of the semen. use, voluntary and involuntary.

The TRANSVERSUS PERINEI (fig. 93, c) is a small thin muscle, which lies across the perineum opposite the base of the triangular ligament. *Arising* from the inner side of the ischial tuberosity at the fore part (fig. 92, p. 241), it is *inserted* into the central point of the perineum with the muscle of the opposite side, and with the sphincter ani and the ejaculator urinæ. In a well-developed muscle some of the fibres are partly continuous with the opposite part of the external sphincter. Behind this muscle the superficial fascia curves round to join the triangular ligament. Transversus perinei : origin ; ends in central point ;

Action. From the direction of the fibres the muscle will draw backwards the central point of the perineum, and help to fix it preparatory to the contraction of the ejaculator. use.

Sometimes there is a second small fleshy strip in front of the transversalis, which has been named *transversalis alter ;* this throws itself into the ejaculator muscle. Accessory transverse muscle.

TRIANGULAR SPACE. The three muscles above described, when separated from each other by dissection, limit a triangular space, of which the ejaculator urinæ forms the inner boundary, the erector penis the outer side, and the transversus perinei the base. In the floor of this interval is the triangular ligament of the urethra, with the superficial perineal vessels and nerves. The knife entering the A triangular space between the three muscles ; the knife may enter

in lithotomy. posterior part of this space during the deeper incisions in the lateral operation of lithotomy will divide the transverse muscle and artery, and probably the superficial perineal vessels and nerves.

Perineal nerve has The PERINEAL BRANCH OF THE PUDIC NERVE (p. 242) breaks up in the fore part of the ischio-rectal fossa into superficial and deep branches. Its two *superficial* offsets have been followed to the scrotum (p. 246). The *deep branches* are *muscular* to the fore parts of the external sphincter and levator ani, to the transversus perinei, erector penis, and ejaculator urinæ, and the *nerve to the bulb*, a long slender branch, which pierces the last muscle and, dividing into filaments, enters the hinder portion of the corpus spongiosum.

cutaneous, muscular, and genital branches.

Dissection of triangular ligament. **Dissection** (fig. 94). For the display of the triangular ligament, the muscles and the crus penis, which are superficial to it, are to be detached on the left side in the following way ;—the ejaculator urinæ is to be removed completely from the corpus spongiosum and the surface of the ligament, and the erector muscle from the crus of the penis. Next, the crus penis is to be detached from the bone ; but this must be done with care so as not to cut the triangular ligament nor to injure the terminal branches of the pudic artery and the dorsal nerve of the penis near the pubic ramus.

Triangular ligament of urethra: The TRIANGULAR LIGAMENT OF THE URETHRA (deep perineal aponeurosis ; fig. 94, c) occupies the anterior part of the sub-pubic arch, and is about one inch and a half in depth in the middle line.

attachments, On each side it is fixed to the pubic and ischial rami beneath the crus penis. Its base is turned towards the rectum, and in the middle line is united with the central point of the perineum ; while laterally it is free and sloped towards the bone, so that the ligament is deeper at the sides than in the centre. Superficial to it are the bulb of the corpus spongiosum and the crura of the penis, with the muscles of the anterior half of the perineal space ; and the superficial fascia joins it along the hinder border. From its deep surface some fibres of the levator ani arise ; and the thin anal fascia is continued backwards from the ligament over that muscle in the ischio-rectal fossa.

and relations;

consists of two strata: The ligament is composed of two layers of membrane (superior and inferior) which are united along the base. The superior layer is derived from the fascia of the pelvis. The inferior layer (now seen) is a separate membrane, formed chiefly of transverse fibres ; but it is so thin as to allow the vessels and the muscular fibres to be seen through it.

apertures in it for urethra, Perforating the inferior layer of the ligament, about one inch from the symphysis pubis, is the canal of the urethra ; but the margin of the opening giving passage to that tube is blended with the tissue of the corpus spongiosum. Nearer the symphysis, and close to the bone on each side, the terminal part of the pudic artery and the dorsal nerve of the penis (*b* and 3) perforate the ligament by separate apertures.

for arteries and nerves of penis;

parts between layers. *Between the layers of the ligament are* contained the membranous part of the urethra, the constrictor urethræ muscle, Cowper's glands,

the pudic vessels with their branches to the bulb, and the dorsal nerves of the penis.

Dissection. The muscle between the layers of the ligament will be reached by cutting through with care, on the left side, the exposed stratum near its attachment to the bone, and raising and turning it inwards. By a little cautious dissection, and the removal Dissection.

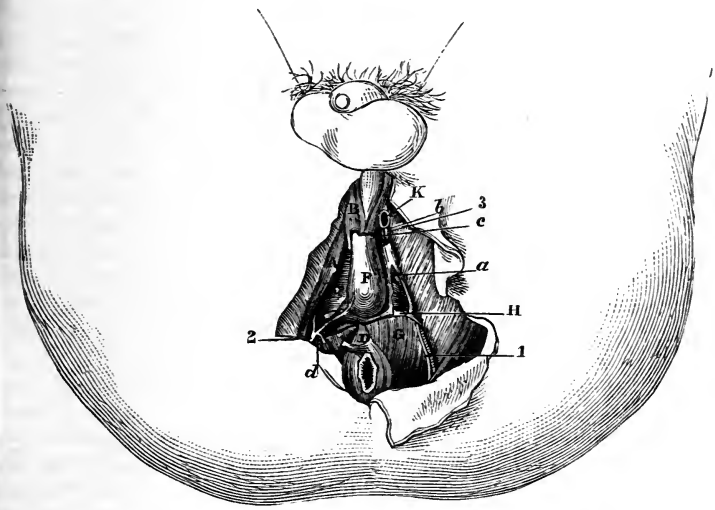


FIG. 94.—DEEP DISSECTION OF THE PERINEUM (ILLUSTRATIONS OF DISSECTIONS).

Muscles, &c.:

A. Erector penis.
B. Ejaculator urinæ, cut.
C. Triangular ligament, inferior layer.
D. External sphincter.
F. Bulb of corpus spongiosum.
G. Levator ani.
H. Superior layer of triangular ligament.
I. Constrictor urethræ.
K. Crus penis, cut.

Arteries:

a. Pudic, in the triangular ligament.
b. Dorsal of penis.
c. Cavernous.
d. Deep muscular branch.

Nerves:

1 and 3. Dorsal of penis.
2. Perineal branch, giving offset to bulb.

of some veins, the fleshy fibres of the constrictor urethræ will be exposed.

The CONSTRICTOR URETHRÆ (fig. 94, I) extends transversely across the sub-pubic arch, enclosing the membranous part of the urethra in the same way as the sphincter ani externus surrounds the end of the rectum. The muscle is attached by tendinous bundles on each side to the rami of the pubis and ischium, and other fibres spring from the two layers of the triangular ligament. Between these attachments the fleshy fibres are directed transversely and obliquely across the middle line, one set passing in front of, and another behind the Constrictor urethræ: attachments; disposition of fibres.

urethra, where they are interrupted in some cases by a small median tendon. At the anterior border of the muscle there is a short fibrous band stretching across between the inferior rami of the pubic bones, and bounding, with the sub-pubic ligament at the lower margin of the symphysis, an oval opening, through which the dorsal vein of the penis enters the pelvis. The hindmost fibres of the constrictor are connected with the central point of the perineum, and are sometimes described separately as the *transversus perinei profundus*.

Transverse ligament.

Deep transverse muscle.

Use of constrictor.

Action. This muscle acts as a sphincter in narrowing the membranous part of the urethra, and ejecting the contents of the tube. It may also aid in producing erection of the penis by compressing the veins of the corpora cavernosa, which are surrounded by its fibres.

Circular fibres of urethra, from the prostate to the bulb:

Involuntary circular fibres within the constrictor muscle surround the urethra from the bulb to the prostate, and form a layer about $\frac{1}{30}$th of an inch thick; they are not fixed to bone, and are continuous above with the circular fibres of the prostate. This layer is a portion of the large involuntary muscle, of which the prostate contains the chief part, surrounding the beginning of the urethra.

use.

Action. This involuntary layer assists in forcing forwards the urine and the semen.

Cowper's glands: situation, size, and structure;

THE GLANDS OF COWPER will be found by cutting through some of the hinder fibres of the constrictor muscle. They are situate behind the membranous part of the urethra, one on each side of the middle line, and close above the bulb. Each gland is about the size of a pea, and is made up of small lobules. They are hard to the feel and can often be located by grasping a portion of the surrounding muscle in the forceps before its removal.

length and termination of the duct;

Connected with each is a minute duct, an inch or more in length, which perforates obliquely the wall of the urethra (corpus spongiosum), and opens into the canal about three-quarters of an inch in front of the triangular ligament. Its aperture in the ordinary state does not admit a bristle.

they vary in size.

These bodies are sometimes so small as to escape detection, and they appear to decrease in size with advancing age.

Dissection of vessels and nerve.

Dissection. The student should now trace out on the right side the pudic vessels with their remaining branches, and the dorsal nerve of the penis. From the point of its division beneath the crus into two branches (dorsal of the penis, and cavernous), the artery is to be followed backwards along the bone; and the nerve will be found by the side of, but deeper than the artery.

Pudic artery: course and ending.

The INTERNAL PUDIC ARTERY has already been dissected in the posterior half of the perineum (p. 242). At the front of the ischio-rectal fossa it penetrates the base of the triangular ligament, and then runs forwards close to the edge of the hip-bone (fig. 94, *a*), in a canal formed by the tendinous origin of the constrictor urethræ. About half an inch behind the symphysis pubis it pierces the inferior layer of the ligament, and immediately divides into the arteries of the corpus cavernosum and the dorsum of the penis. It is accompanied by

venæ comites and the dorsal nerve of the penis. Its offsets in this part of its course are :— Branches :—

a. Deep muscular branches (*d*). As the artery is about to enter between the layers of the triangular ligament it furnishes one or more branches to the levator ani and sphincter, and fine twigs through the ligament to the constrictor and the urethra. Muscular.

b. The *artery of the bulb* is a branch of considerable size, which arises near the base of the triangular ligament. It passes almost transversely inwards between the fibres of the constrictor muscle, about half an inch from the base of the triangular ligament, and reaches the upper surface of the bulb to enter the spongy structure. Near the urethra it furnishes a small branch to Cowper's gland. Artery of bulb in the triangular ligament :

The distance of this branch from the base of the ligament will be influenced by its origin being nearer the front or back of the perineal space. If it arises earlier than usual it may be altogether behind the ligament and cross the front of the ischio-rectal fossa, so as to be liable to be cut in the operation of lithotomy. its situation varies.

c. The *artery of the corpus cavernosum* (*c*) is one of the terminal branches of the internal pudic. At first this vessel lies between the crus penis and the bone, but it soon enters the crus, and ramifies in the cavernous structure of the penis. Artery of body of penis.

d. The *dorsal artery of the penis* (*h*) is in direction the continuation of the internal pudic ; it runs upwards between the crus and the bone, and reaches the dorsum of the penis by passing through its suspensory ligament. Its distribution with the accompanying nerve will be noticed directly. Artery of dorsum of penis.

Accessory pudic artery. In some cases the pudic artery is not large enough to supply the branches above described to the penis and the urethra. One or more offsets will then be contributed by an accessory vessel, which leaves the pelvis in front by piercing the triangular ligament. The source of this accessory artery is the internal iliac (p. 399). Accessory pudic artery : source.

The *pudic veins*, two in number, have frequent communications together, so as to form a plexus round the artery ; they receive similar branches, except that the dorsal vein of the penis does not join them. Pudic veins.

The DORSAL NERVE OF THE PENIS has been seen in the ischio-rectal fossa (p. 243). In the anterior half of the perineum it takes a similar course to the pudic artery, but at a deeper level and in a distinct sheath within the triangular ligament, and then pierces the superficial layer of that structure close to the inferior ramus of the pubis, to be continued with the dorsal artery to the penis. On its way the nerve supplies filaments to the constrictor urethræ muscle. Dorsal nerve of the penis.

Dissection. The ejaculator urinæ muscle will now be carefully cleared away from the subjacent bulbous and spongy part of the urethra, and the erector penis muscles will be similarly removed to fully expose the crura.

The CRURA OF THE PENIS are attached on each side to the conjoined rami of the pubis and ischium for about an inch, and it will be seen crura of penis.

that they are the pointed posterior extremities of two dense cylindrical tubes of fibrous tissue (the *corpora cavernosa*) containing erectile tissue, which blend about an inch and a half from their posterior extremities to form the body of the penis. A slight enlargement will be noticed on each crus, which has been called the bulb of the corpus cavernosum (Kobelt). The structure of the corpora cavernosa will be seen at a later stage.

Bulb of urethra.

The BULB OF THE URETHRA is an enlargement of the vascular and erectile tissue (the *corpus spongiosum*) which surrounds the urethra from the triangular ligament onwards. The bulb is firmly united to the under surface of the triangular ligament and usually presents a slight central depression, with a bulging on each side forming two lateral lobes.

Tegumentary covering of penis is thin, and without fat,

CUTANEOUS COVERINGS OF THE PENIS AND SCROTUM. The penis is attached to the front of the pelvis by a suspensory ligament, and is provided with a tegumentary covering continuous with that of the abdomen, but devoid of fat.

forms prepuce,

Around the end of the penis it forms the loose sheath of the prepuce in the following way :—When the skin has reached the extremity, it is reflected backwards as far as the base of the glans, constituting thus a sheath with two layers—the *prepuce*; it is afterwards continued over the glans, and joins the mucous membrane of the urethra at the orifice on the surface. At the under part of the glans and behind the aperture of the urethra, the integument forms a small triangular fold, *frænum præputii*.

and frænum.

Sebaceous glands.

Where the skin covers the glans, it is inseparably united with that part, is very thin and sensitive, being provided with papillæ, and assumes in some cases the characters of a mucous membrane. Behind the glans are some sebaceous follicles—*glandulæ odoriferæ*.

Teguments in scrotum.

In the scrotum the two layers of the superficial fascia of the groin become united in a thin membrane of a reddish colour. The prolongation around the testicle on one side is separate from that on the other side ; and the two pouches, coming in contact in the middle line, form the *septum scroti*.

Muscular nature of fascia.

The subcutaneous layer in the scrotum, penis, and front of the perineum contains involuntary muscular fibres, to which the corrugation of the skin is owing. This contractile structure is named the *dartoid tissue*.

Dissection of vessels and nerves.

Dissection. The scrotum should now be accurately divided into two halves by an incision in the middle line and each half containing its testis is to be held aside. The incision should be continued along the under surface of the penis to the frænum and the skin of the organ dissected off as a sheath. The staff is to be removed from the urethra and the fatty tissue from the root of the penis and the front of the symphysis pubis should be removed so as to define the suspensory ligament. The dorsal arteries and nerves, with the dorsal vein of the penis, which will be laid bare, are to be followed forwards to the glans.

Suspensory

The *suspensory ligament of the penis* is a band of fibrous tissue

of a triangular form, which is attached by its apex to the front of the symphysis pubis. Widening below, it is fixed to the upper surface of the body of the penis, and is prolonged for some distance on the organ. Perforating the ligament at its junction with the penis are the dorsal vessels and nerves. ligament of penis; attachments; contains vessels and nerves.

The DORSAL ARTERY, on each side, pierces the suspensory ligament, and extends forwards to the glans, where it ends in many branches for that structure: in its course the vessel supplies the integuments and branches to the body of the penis. Dorsal artery of penis.

The DORSAL VEIN is a single trunk, and commences by numerous branches from the glans penis and the prepuce. It runs backwards, between the two arteries, through the suspensory ligament, and then through a special opening below the sub-pubic ligament, to join the prostatic plexus of veins. The vein receives branches from the erectile structure and from the integuments of the penis. Dorsal vein ends in prostatic plexus.

Each DORSAL NERVE takes the same course as the artery, and ends like it in numerous branches to the glans penis. It furnishes twigs to the corpus cavernosum penis, and other offsets to the integuments of the dorsum, sides, and prepuce of the penis. Dorsal nerve of pudic.

In the female these vessels and nerves are much smaller than in the male, and occupy the upper surface of the clitoris—the organ that represents the penis. Vessels on clitoris.

The BODY OF THE PENIS is rather prismatic in shape. The upper surface is slightly grooved along the middle line; and the lower rounded border is formed by the corpus spongiosum, which is received into a groove between the corpora cavernosa. forms and attachment.

The *corpus spongiosum urethræ* encloses the urethral canal beyond the triangular ligament, and forms the head of the penis. It is a vascular and erectile texture, like the corpora cavernosa, but is much less strong. Commencing posteriorly in the bulb, it extends forwards around the urethra to the extremity of the penis, where it swells into the conical glans penis. Corpus spongiosum, surrounds urethra, and swells into the bulb, and the conical glans penis.

The *glans penis* is somewhat conical in form, and covers the truncated ends of the corpora cavernosa. Its base is directed backwards, and is marked by a slightly prominent border—the *corona glandis;* it is sloped obliquely along the under aspect, from the apex to the urinarius base. In the apex is the vertical slit (meatus) in which the urethral canal terminates, and below that aperture is an excavation which holds the fold of skin named the *frænum præputii.*

Direction. The student should be careful not to damage the urethra, as it will be examined at a later stage.

PARTS CUT IN THE LATERAL OPERATION OF LITHOTOMY. This operation for stone in the bladder may be divided into three stages, viz., cutting down to the urethra, opening the canal, and slitting the tube and the neck of the bladder. In the external incision the knife is entered near the middle line of the perineum, one inch in front of the anus, and is drawn backwards on the left side as far as midway between the ischial tuberosity and the anus. The skin and fat, the transverse perineal muscle and artery, the inferior Parts cut in lithotomy, in cutting down to urethra,

hæmorrhoidal vessels and nerve lying across the ischio-rectal fossa, and possibly the superficial perineal vessels and nerves, will be cut in this first stage of the operation.

in reaching the staff,

In the subsequent attempt to reach the staff, when the knife is introduced into the front of the wound, the hinder part of the triangular ligament and constrictor urethræ, and the fore part of the levator ani will be divided; when the knife is placed within the groove of the staff, the membranous part of the urethra will be cut with the muscular fibre about it.

and in running knife along staff.

Lastly, as the knife is pushed along the staff into the bladder, it incises in its progress the membranous portion of the urethra, part of the prostate with large veins around it, and the neck of the bladder. When the last two parts are being cut, the handle of the knife is to be raised, and the blade depressed; and the incision is to be made downwards and outwards, in the direction of a line from the urethra through the left lateral lobe of the prostate, above the level of the ejaculatory duct.

Parts to be avoided are rectum,

Parts to be avoided. In the first incision in the ischio-rectal fossa, the rectum may be cut if the knife is turned inwards across the intestine, instead of being kept parallel with it; and if the gut is not held out of the way with the forefinger of the left hand.

pudic vessels,

The pudic vessels on the outer wall of the ischio-rectal fossa may be wounded near the anterior part of the hollow, where they approach the margin of the triangular ligament; but, posteriorly, they are securely lodged inside the projection of the ischial tuberosity.

artery of bulb,

While making the deeper incisions to reach the staff, the artery of the bulb lies immediately in front of the knife, and will be wounded if the incisions are made too far forwards; but the vessel must almost necessarily be cut, when it arises farther back than usual, and crosses the front of the ischio-rectal fossa in its course to the bulb of the urethra.

recto-vesical fascia,

In the last stage of the operation the neck of the bladder should not be incised to a greater extent than is necessary for the extraction of the stone, lest the recto-vesical fascia separating the perineum from the pelvis should be divided, and the abdominal cavity opened.

and accessory pudic artery.

Too large an incision through the prostate may wound also an unusual accessory pudic artery on the side of that body.

Directions.

Directions. When the dissection of the perineum is completed, the flaps of skin along the under surface of the penis and the two halves of the scrotum are to be stitched together; all the parts are to be carefully wrapped in tow containing preservative, and the body will be turned on its face for dissection of the back. On the third day of this dissection the worker on the abdomen will examine the different layers of the lumbar fascia, and the posterior aponeurosis of the transversalis made in conjunction with the dissector of the head and neck.

Section II.

PERINEUM OF THE FEMALE.

Perineum of female has special parts.

The perineum in the female differs from that in the male more in the external form than the internal anatomy. On the surface it has special parts distinguishing it, viz., the aperture of the vagina and the surrounding vulva, which occupy the position of the scrotum in the male.

Apertures of anus and vulva.

Surface-marking.—External organs of generation. In the middle line there are the aperture of the anus and the cleft of the vulva, which are separated from one another by an interval of about an inch. The anus is situate a little further back than in the male.

External labia.

The cleft or *rima* of the vulva is bounded at the sides by the *labia majora*, two prominent folds, thick and rounded in front but becoming thinner as they pass backwards, which correspond to the scrotum of the male. The labia are formed externally by skin, which is provided with scattered hairs, and internally by mucous membrane. They are united in front and behind in the *anterior* and *posterior commissures.*

and commissures.

Clitoris.

Internal labia

Within the rima, at the fore part, is the *clitoris*, from which two folds of mucous membrane, the *labia minora* or *nymphæ*, extend backwards, one on each side of the aperture of the vagina. At its anterior end each nympha divides into two smaller folds, the outer of which unites with the one of the opposite side so as to form a kind of hood over the front of the clitoris—the *præputium clitoridis*, while the inner one, much shorter and thinner, is attached to the back of the clitoris in contact with its fellow, the two constituting the *frænulum clitoridis.*

Prepuce and frænum of clitoris.

Vestibule.

Opening of urethra.

Enclosed by the labia minora, and between the clitoris and the orifice of the vagina, is a median recess about an inch and a half deep, which is called the *vestibule.* At the hinder part of the vestibule is the orifice of the urethra (*meatus urinarius*), surrounded by a slight eminence, about an inch behind the clitoris, and near the aperture of the vagina.

Aperture of vagina.

Hymen and caruncles.

The *orifice of the vagina* varies much in size; and in the child and virgin it is often partly closed behind by a thin semilunar fold of the mucous membrane—the *hymen.* After the destruction of the hymen, small, irregularly shaped projections, the *carunculæ myrtiformes*, are found in its place.

Fourchette and fossa navicularis.

At the back of the rima, within the posterior commissure of the labia, is a narrow transverse fold of the integument called the *fourchette* or *frænulum pudendi;* and to the interval between the frænulum and the commissure the name *fossa navicularis* is given.

Boundaries alike in both sexes.

Deep boundaries. The deep boundaries of the perineum are alike in both sexes; but in the female the outlet of the pelvis is larger than in the male.

Dissection.

Dissection. The steps of the dissection are much the same in both sexes, and the same description will serve, generally, for the male and female perineum.

Take first ischio-rectal fossa.

First, the dissection of the ischio-rectal fossa is to be made. Afterwards the muscles, vessels and nerves of the posterior half of the perineal space are to be examined. (See description of the male perineum, pp. 237 to 243.)

Then examine anterior half of perineum.

Next, the skin is to be taken from the anterior half of the perineal space, as in the male; and the transverse incision in front is to be made at the anterior part of the vulva. The attachments of the superficial fascia are then to be looked to, and the cutaneous vessels and nerves are to be traced beneath it (p. 244 *et seq.*).

Superficial fascia.

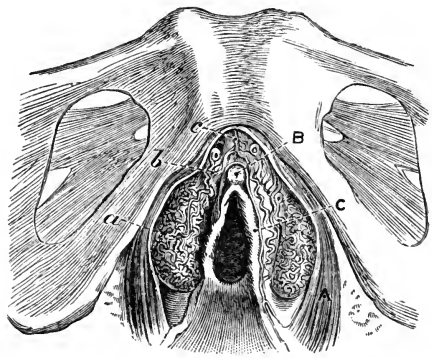


FIG. 95.—VENOUS PLEXUSES OF THE GENITAL ORGANS, AND OPENING OF THE VAGINA (KOBELT).

A. Sphincter vaginæ muscle.
B. Clitoris.
C. Nympha.
a. Bulb of the vestibule.
b. Venous plexus continuous with veins of the clitoris.
c. Dorsal vein of the clitoris.

Superficial fascia. The description of this fascia in the male will serve for the like part in the female, with these modifications:—that in the female it is interrupted in the middle line, and is of less extent, in consequence of the aperture of the vulva; and that it is continued forwards through the labia majora to the inguinal region. In the labia the superficial fascia contains involuntary muscular fibres, like the dartos tunic of the scrotum, as well as fat.

Dartoid tissue.

Superficial vessels and nerves.

The SUPERFICIAL PERINEAL VESSELS and NERVES, and the INFERIOR PUDENDAL NERVE have the same arrangement as in the male (p. 245); but they are distributed to the labia instead of to the scrotum.

Dissection of the muscles.

Dissection. The labia and the superficial fascia are then to be removed, to follow the sphincter muscle around the opening of the vagina. Two other muscles are exposed at the same time, viz., the erector clitoridis lying along the ramus of the ischium, and the transversus perinei passing across the perineum to the central point.

Sphincter vaginæ: origin

The SPHINCTER VAGINÆ (bulbo-cavernosus; fig. 95, A) is a partially orbicular muscle around the orifice of the vagina, and corresponds to the ejaculator urinæ in the male. Posteriorly it is attached to the central point of the perineum, where it blends with the sphincter ani and transversus muscles; and its fibres are directed forwards on

each side of the vagina, to be *inserted* into the body of the clitoris. The muscle covers the bulb of the vestibule and the gland of Bartholin by the side of the entrance to the vagina. insertion; relations;

Action. Like the other orbicular muscles, the sphincter diminishes that part of the vagina which it encircles; and it assists in fixing the central point of the perineum. and use.

The ERECTOR CLITORIDIS (ischio-cavernosus) resembles the erector of the penis in the male, though it is much smaller (see p. 246). Erector clitoridis.

The TRANSVERSUS PERINEI is similar to the muscle of the same name in the male. The one description will suffice for the muscle in both sexes (see p. 247). Superficial transverse muscle.

Dissection. The sphincter vaginæ should now be carefully removed from the subjacent bulb of the vestibule, and the erector muscles from the crura of the clitoris.

The BULB OF THE VESTIBULE (semi-bulb, Taylor, fig. 95, *a*) is an elongated and flattened mass of cavernous or erectile tissue, which is enclosed in a thin fibrous coat. It lies by the side of the vestibule and the entrance to the vagina, above (deeper than) the nympha, resting against the lower surface of the triangular ligament, and being covered by the sphincter vaginæ muscle (A). Each is about an inch and a half long, and is larger at its hinder end, where it measures about half an inch in depth. By their narrow anterior ends the two bulbs are united in front of the urethra by a small connecting venous plexus—the *pars intermedia;* and they are joined by a venous plexus to the small glans of the clitoris. These bodies answer to the divided bulb of the corpus spongiosum urethræ in the male. Bulbs of vestibule: situation; relations; size; connected to clitoris;

The CLITORIS (fig. 96, *b*. p. 258) is a small erectile body, and is the representative of the penis. It has the same composition as the penis, except that the urethra is not continued along it. Its anterior extremity is terminated by a rounded part or glans (*c*), and is covered by a fold of the mucous membrane corresponding to the prepuce of the male. is like the penis; has a glans and prepuce;

In its structure this organ resembles the penis in the following particulars:—It consists of corpora cavernosa, which are attached by crura (one on each side, *a*) to the ischio-pubic rami, and are blended in the body. A small suspensory ligament descends to it from the superficial fascia of the mons Veneris; and along the middle is an imperfect pectiniform septum. Moreover, it possesses a portion of corpus spongiosum, but this structure is limited to the glans clitoridis (*c*). (The penis is described on p. 253.) composition, corpora cavernosa, corpus spongiosum

Structure. The outer fibrous casing and the septum are alike in both penis and clitoris; and in the interior of the clitoris is an erectile tissue, like that in the male organ. and erectile tissue.

The *blood-vessels* of the clitoris are like those of the penis, and the glans receives the dorsal artery (p. 253).

Dissection. To see the triangular ligament of the urethra, the erector and the crus clitoridis are to be detached from the bone on the left side. To expose triangular ligament.

Triangular ligament.

The TRIANGULAR LIGAMENT transmits the urethra, but is not so strongly marked as in the male (see p. 248); it is interrupted to a large extent in the middle line by the aperture of the vagina.

To see deep muscle.

Dissection. By cutting through the superficial layer of the ligament in the same way as in the male (p. 249), the deep muscle, with the pudic vessels and their branches, and the dorsal nerve of the clitoris, will be arrived at.

Deep transverse muscle.

The TRANSVERSUS PERINEI PROFUNDUS is the representative of the constrictor urethræ of the male (p. 249). It *arises* on each side from the pubic and ischial rami; and the fibres are directed inwards to be *inserted* mainly into the side of the vagina. The hindmost ones join

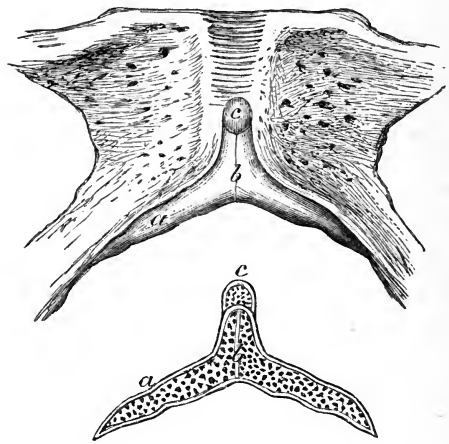


FIG. 96.—THE CLITORIS.

a. Crus, and *b*, body of the corpus cavernosum.
c. Glans clitoridis.

The lower figure shows the structure on a vertical section; the same letters refer to like parts.

the central point of the perineum; and anteriorly some are continued across from side to side in front of the urethra. Beneath the last is a circular layer of involuntary fibres, as in the other sex.

Glands of Bartholin:

GLANDS OF BARTHOLIN. At the hinder part of the entrance to the vagina on each side is a yellowish glandular body, which corresponds to Cowper's gland in the male (p. 250). It has the shape and size generally of a small bean, its greatest length, which is directed from

shape and size;

before backwards, measuring about half an inch. It lies close to the hinder end of the bulb of the vestibule, and is covered by the fibres

duct.

of the sphincter vaginæ. The duct is directed forwards and downwards for about three-quarters of an inch, to open on the inner aspect of the nympha of the same side, immediately below the hymen or its remains.

The description of the INTERNAL PUDIC ARTERY (p. 249) will serve for both sexes, except that the branch to the bulb is small, and is furnished to the bulb of the vestibule. The terminal branches are the artery of the corpus cavernosum and the dorsal artery of the clitoris, and are also much smaller than the corresponding vessels in the male. Pudic vessels.

The PUDIC NERVE has the same arrangement as in the male. From its perineal division proceed the two superficial nerves, branches to the superficial muscles, and an offset to the bulb. The dorsal nerve of the clitoris is of small size. Pudic nerve.

Note.—See the "Directions" at the bottom of page 254.

CHAPTER VI.

DISSECTION OF THE ABDOMEN.

SECTION I.

WALL OF THE ABDOMEN.

Position of the body.

Position. The body will be sufficiently raised by blocks beneath the thorax and head for the dissection of the upper limbs and neck, but the dissector should see that the chest is higher than the pelvis. If the abdomen is flaccid, it may be inflated through an aperture in the umbilicus, but if it is firm, proceed with the dissection without blowing it up.

Appearances on the surface of the abdomen.

Surface-marking. On its anterior aspect the abdomen is fairly uniformly convex, especially in fat bodies ; but at the side there is a slight hollow below the ribs, and a groove marks the position of the iliac crest. Along the middle line is a groove over the linea alba, which begins above in a depression over the ensiform process (*epigastric* or *infrasternal fossa*), and becoming gradually shallower below ends a little beyond the umbilicus. The latter is a round, depressed cicatrix, situate nearer to the pubic bones than to the lower end of the body of the sternum, and opposite, as a rule, the disc between the third and fourth lumbar vertebræ. On each side of the median groove is the elevation of the rectus muscle, which is intersected in adult well-formed bodies by two or three transverse furrows.

Pit of the stomach.

Navel.

Eminence of pubes.

Over the lower ends of the recti and the adjacent parts of the pubic bones the surface is somewhat elevated, owing to an accumulation of fat ; and the name *pubes* has been given to this part from its thick covering of hair. This projection is especially marked in front of the bones in the female, where it is distinguished as the *mons Veneris*. Beneath the eminence of the pubes the student will be able to recognise with his finger the symphysis pubis, and to trace outwards from it the osseous pubic crest, which leads to the prominent pubic spine. From this to the anterior superior iliac spine the curved *inguinal furrow* extends, separating the abdomen from the thigh. If the finger be carried along the furrow it will detect the firm band of Poupart's ligament, and sometimes one or two inguinal glands.

Mons Veneris.

Inguinal furrow.

Poupart's ligament.

Abdominal rings, outer

Immediately above and to the outer side of the pubic spine the opening of the external abdominal ring may usually be felt ; and in

the male, the prominence of the spermatic cord descending through it to the testicle. The internal abdominal ring is farther out than the external, and cannot be recognised on the surface with the finger; its position may be ascertained by taking a point midway between the symphysis pubis and the anterior superior iliac spine, and a finger's breadth above Poupart's ligament. and inner.

Dissection. The requisite incisions for raising the skin from the sides and front of the belly are the following:—One cut is to extend outwards over the side of the chest from the ensiform process to about midway between the sternum and the spine (fig. 1, B.[7], p. 3). A second incision begins at the symphysis pubis, and is carried outwards along Poupart's ligament and the iliac crest till it ends opposite the first cut (8). Lastly, the anterior extremities of the two incisions are to be connected along the middle line of the belly (3). The piece of skin thus marked out is to be raised outwards, but is not to be taken away; and the cutaneous vessels and nerves are to be sought in the fat at the side and front of the abdomen. Raise the skin from the front.

Along the side of the abdomen look for the lateral cutaneous nerves (fig. 97, p. 263), five or six in number, which issue in a line with the corresponding nerves of the thorax. At first they lie beneath the fat, and divide into two; one offset is to be traced forwards and the other backwards, with small cutaneous arteries. On the iliac crest, near the front, is a large branch from the last dorsal nerve; and usually farther back on the crest, and deeper, is a smaller branch of the ilio-hypogastric nerve. Near the middle line the small anterior cutaneous nerves will be recognised with companion arteries: they are uncertain in number and size, and are to be followed outwards in the fat. Position of cutaneous nerves: on the side and in front.

In the inguinal region the cutaneous vessels and nerves are to be dissected on the right side, and the superficial fascia on the left. For this purpose, all the fascia superficial to the vessels is to be removed from the right groin. The vessels which will then appear are the superficial external pudic internally, the superficial epigastric in the centre, and an offset of the superficial circumflex iliac artery externally. Some inguinal glands lie along the line of Poupart's ligament. Two cutaneous nerves are to be sought:—one, the ilio-inguinal, comes through the external abdominal ring, and descends to the thigh and scrotum (fig. 97, I—I); the other, ilio-hypogastric, appears in the superficial fascia above, and rather outside the abdominal ring (I-H). Seek vessels and nerves in right groin.

In the examination of the superficial fascia on the left side two strata are to be made out, one over and one beneath the vessels. The layer that is superficial to the vessels is to be reflected by means of a transverse cut directed inwards from the front of the iliac crest, and by a vertical one near the middle line to the pubic bone. The subjacent vessels mark the depth of this layer; and when these are reached, a triangular flap of the fascia is to be thrown towards the thigh. To define the thinner deep stratum, cut it across in the Separate fascia in left groin into superficial and deep layers.

same manner as the other layer, and detach it carefully with the vessels from the underlying aponeurosis of the external oblique muscle. This stratum, like the preceding, is to be traced around the cord to the scrotum; and as the student follows it downwards he will find it connected with Poupart's ligament, and blended with the fascia lata close below that structure.

Superficial fascia is divided into two layers.

The SUPERFICIAL FASCIA is a single layer over the greater part of the abdomen; but in the groin it is divided into a subcutaneous and a deeper stratum by the vessels and the glands.

The subcutaneous layer contains fat, except in the penis and scrotum.

The *subcutaneous layer* contains the fat, and varies therefore in appearance and thickness in different bodies; for it is sometimes divisible into strata, while in other cases it is very thin, and somewhat membranous near the thigh. It is continuous with the fatty covering of the thigh and abdomen, and, when traced to the limb, is separated from Poupart's ligament beneath by the superficial vessels and glands. Internally it is continued to the penis and scrotum, where it changes its adipose tissue for involuntary muscular fibre; and after investing the testicle it is prolonged to the perineum.

Deeper layer is thin and membranous; special characters and disposition; and ends on fascia lata.

The *deeper layer* (fascia of Scarpa) is thinner and more membranous than the other, and is closely united to the tendon of the external oblique by fibrous bands along the linea alba. Like the subcutaneous part, this layer is continued upwards on the abdomen, and inwards to the penis and the scrotum, through which it is prolonged to the perineum, where it has attachments to the subjacent parts, as before specified (p. 244). Towards the limb, it ends a little below Poupart's ligament by joining the fascia lata across the front of the thigh.

Attachments determine course of effused urine.

Urine effused in the perineum from rupture of the urethra will be directed through the scrotum and along the spermatic cord to the abdomen. From the attachment of the deeper layer to the fascia across the thigh, it is evident that the fluid cannot pass down the limb, though its progress over the front of the abdomen is uninterrupted.

Fascia in the female.

In the female the superficial fascia of the groin is separable into two layers, and the disposition of each is nearly the same as in the male; but the part that is continued to the scrotum in the one sex enters the labium in the other. In the female the round ligament of the uterus is lost in it.

Cutaneous nerves are derived from two sources.

CUTANEOUS NERVES. The skin of the abdomen is supplied mainly by the lower intercostal nerves; thus, the cutaneous branches along the side of the belly are offsets from five or six of those nerves; and the cutaneous branches along the front are the terminal parts of the same trunks. Two other cutaneous offsets from the lumbar plexus, viz., ilio-hypogastric and ilio-inguinal, appear at the lower part of the abdomen.

Lateral cutaneous of intercostal,

The LATERAL CUTANEOUS NERVES (fig. 97) of the abdomen emerge between the digitations of the external oblique muscle, in a line with the same set of nerves on the thorax; and the lowest are the most

posterior. As soon as they reach the surface they divide, with the exception of the last, into an anterior and a posterior branch :— which divide into

The *posterior branches* are small, and are directed back to the integuments over the latissimus dorsi muscle. posterior and

The *anterior branches* are continued forwards nearly to the edge of the rectus muscle, and increasing in size from above downwards, supply the integuments on the side of the belly ; they furnish offsets to the digitations of the external oblique muscle. anterior branches.

The *lateral cutaneous branch of the last dorsal nerve* is larger than the others and does not divide like them. After piercing the fibres of Last dorsal nerve.

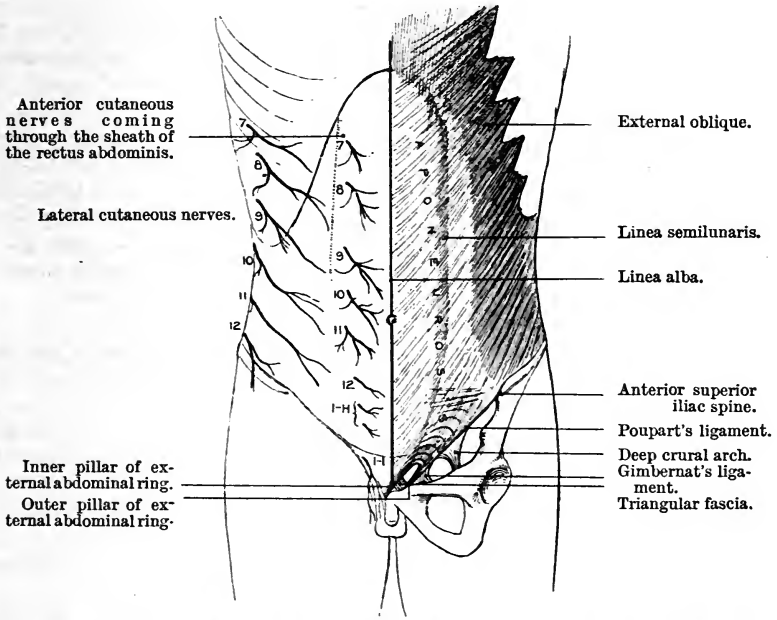


FIG. 97.—DIAGRAM OF THE CUTANEOUS NERVES OF THE ABDOMEN AND OF THE EXTERNAL OBLIQUE MUSCLE.

the external oblique muscle, it is directed over the iliac crest to the surface of the gluteal region (p. 110).

The ANTERIOR CUTANEOUS NERVES of the abdomen pierce the sheath of the rectus ; in the integuments they bend outwards towards the lateral cutaneous nerves. The number and the situation of these small nerves are very uncertain. Anterior cutaneous nerves of intercostal.

The ILIO-HYPOGASTRIC NERVE is distributed in two branches : one passes over the crest of the ilium (iliac branch) ; the other ramifies on the lower part of the abdomen (hypogastric branch) :— Ilio-hypogastric of lumbar plexus :

(*a*) The *iliac branch* lies close to the crest of the hip-bone near the last dorsal nerve, and enters the fat of the gluteal region (p. 110). iliac branch,

hypogastric branch. (*b*) The *hypogastric branch* pierces the aponeurosis of the external oblique muscle above the abdominal ring in one or two pieces, and is distributed to the skin of the lower part of the abdomen.

Ilio-inguinal nerve of the plexus. The ILIO-INGUINAL NERVE becomes cutaneous through the external abdominal ring, and descends to the teguments of the scrotum and of the upper and inner part of the thigh.

Vessels with nerves; CUTANEOUS VESSELS. Cutaneous vessels run with both sets of nerves on the abdomen. With the lateral cutaneous nerves are branches from the intercostal arteries; and with the anterior cutaneous are offsets from the internal mammary and epigastric vessels. In the groin are three small superficial branches of the femoral artery, viz., pudic, epigastric, and circumflex iliac.

both lateral The LATERAL CUTANEOUS ARTERIES have the same distribution as the nerves they accompany. The anterior or chief offsets are directed towards the front of the abdomen, and end about the outer edge of the rectus muscle.

and anterior cutaneous. The ANTERIOR CUTANEOUS ARTERIES are irregular in number and in position, like the nerves. After piercing the sheath of the rectus, they run outwards with the nerves towards the other set of branches.

From femoral artery three branches: BRANCHES OF THE COMMON FEMORAL ARTERY. Three cutaneous offsets ascend from the thigh between the layers of the superficial fascia, and ramify in the integuments of the genital organs and lower part of the abdomen. The beginning of these vessels appears in the dissection of the thigh (p. 138).

external pudic, The *superficial external pudic branch* crosses the spermatic cord, to which it gives offsets, and ends in the integuments of the under-part of the penis.

superficial epigastric, The *superficial epigastric branch* ascends over Poupart's ligament near the centre, and is distributed in the fat nearly as high as the umbilicus.

circumflex iliac. The *superficial circumflex iliac branch* lies below the level of Poupart's ligament, and sends only a few offsets to the abdomen.

Veins. The companion *veins* to these arteries join the internal saphenous vein of the thigh.

Inguinal glands: The LYMPHATIC GLANDS OF THE GROIN are three or four in number, and lie along the line of Poupart's ligament. They are placed between the strata of the superficial fascia, and receive lymphatics from the abdominal wall, from the gluteal region and perineum, from the upper and outer portion of the thigh and from the superficial parts of the genital organs. Their efferent ducts pass downwards to the saphenous opening in the thigh to enter the abdomen.

ducts enter abdomen.

To expose external oblique muscle. **Dissection of the Muscles.** The surface of the external muscle of the abdominal wall (figs. 97 and 98) is now to be freed from fascia on both sides of the body.

Precautions. It is not advisable to begin cleaning this muscle in front, because there it has a thin aponeurosis, which may be taken away with the fat. Beginning the dissection at the posterior part, the student is to carry the knife obliquely upwards and downwards in the direction of the fibres. The thin aponeurosis before referred to

is in front of a line extended upwards from the anterior end of the iliac crest, and as the dissector approaches that part he must be careful not to injure the tendon, more particularly above, where it lies on the margin of the ribs, and is very indistinct.

On the left side the external abdominal ring (C) may be defined, to show the spermatic cord passing through it ; but on the right side a thin fascia (intercolumnar), which is connected with the margin of that opening, is to be preserved. Lastly, the free border of the external oblique should be made evident between the last rib and the iliac crest.

To define abdominal ring.

Muscles of the Abdominal Wall. On the side of the abdomen are three large flat muscles, which are named from their position to one another, and from the direction of their fibres : the *external oblique;* the *internal oblique;* and the deepest, the *transversalis.*

On the side are three flat muscles,

the aponeuroses of which encase three vertical.

External oblique muscle :

origin from ribs ;

Fig. 98.

A. The external oblique muscle.
B. Poupart's ligament.
C. External abdominal ring.
D. Gimbernat's ligament.

Near the middle line are placed other muscles which have a vertical direction ; namely, the rectus and the pyramidalis ; and behind is the quadratus lumborum : these all are encased by sheaths derived from the aponeuroses of the lateral muscles, and will be subsequently seen.

The external oblique muscle (fig. 98, A, and fig. 97) is fleshy on the side, and aponeurotic on the fore part of the abdomen. It *arises* by fleshy processes from the eight lower ribs, the five highest pieces alternating with similar parts of the serratus magnus, and the lowest three with slips of the latissimus dorsi muscle. From the attachment to the ribs the fibres are directed over the side of the abdomen to end in the following manner :—the lower ones descend almost vertically to be *inserted* into the anterior half or more of the outer margin of the iliac crest (fig. 47, p. 113) ; and the upper and middle fibres are continued forwards obliquely to the tendon or aponeurosis on the front of the belly.

insertion into pelvis and linea alba.

The *aponeurosis* occupies the front of the abdomen, internal to a line drawn from the prominence of the ninth rib-cartilage to a point about an inch and a half in front of the anterior superior iliac spine ; and it is broader below than above. Along the middle line it ends in the *linea alba*—the common place of union in the

Aponeurosis covers front of the belly ;

disposition above and below.

middle line of the aponeuroses of opposite sides. Above, it is thin, and is continued over the thorax to the pectoralis major muscle. Below, its fibres are stronger and more distinct than above, and are directed obliquely downwards and inwards to the pelvis ;—some of them are fixed to the front of the pelvis ; and the rest are collected into a firm band, *Poupart's ligament*, between the pubic spine and the iliac crest (p. 267).

Relations.

Relations. The muscle is subcutaneous. Its posterior border is unattached between the last rib and the iliac crest, but it is usually overlapped by the edge of the latissimus dorsi, except for a short distance below.

Lines on the aponeurosis ;

At the outer part of the aponeurosis in the front of the abdomen is a curved white line, the *linea semilunaris*, marking the outer edge of the rectus muscle (fig. 97) ; and crossing between this and the linea alba are three or four somewhat irregular lines—the *lineæ transversæ*.

apertures in it ;

Numerous small apertures in the aponeurosis transmit cutaneous vessels and nerves ; and near the pubis is the

abdominal ring.

large opening of the external abdominal ring (fig. 97), which gives passage to the spermatic cord in the male, and to the round ligament in the female.

Use of both muscles, acting from pelvis,

Action. Both muscles, taking their fixed point at the pelvis, will bend the trunk forwards ; but with the spine fixed, they will draw down the ribs. If they act from the thorax they will elevate the pelvis.

and thorax ;

Should one muscle contract, it will incline the trunk to the same

one muscle acting ;

side, or raise the pelvis, according as the upper or the lower attachment may be movable ; or if the trunk is prevented from being bent, it will turn the thorax to the opposite side.

influence on abdominal cavity.

The external oblique also acts powerfully with the other broad muscles in flattening the wall and diminishing the cavity of the abdomen, and in forcing up the diaphragm during expiration by means of pressure transmitted through the abdominal viscera.

Direction. Besides the general arrangement of the aponeurosis over the front of the abdomen, the student is to examine more minutely the linea alba in the middle line, the external abdominal ring with the fascia prolonged from its margin, and the thickened border named Poupart's ligament.

In the linea alba the aponeuroses are united.

Linea alba. This white band on the front of the abdomen marks the place of meeting of the aponeuroses of the opposite sides. It extends from the ensiform process to the pubic symphysis, and is wider above than below. It is perforated here and there by small apertures, which allow pellets of fat to protrude sometimes. A little below the centre is the umbilicus, which now projects beyond the surface, though before the skin was removed a hollow indicated its position.

External abdominal ring :

External abdominal ring (fig. 97 and fig. 98, c). This opening is situate near the pubes, between the diverging fibres of the aponeurosis. It is somewhat triangular in form, with the base at the pubic

form and situation ;

crest, and the apex directed upwards and outwards. The long

size ;

measurement of the aperture is about an inch, and the transverse about half an inch.

Its margins are named pillars, and differ in form and strength. The inner one, thin and straight, is attached below to the front of the symphysis pubis, where it decussates with the corresponding piece of the opposite side. The outer pillar is stronger, and is curved, so as to form a kind of groove for the support of the spermatic cord; it is continuous with Poupart's ligament and is attached below to the pubic spine. A thin membrane (intercolumnar fascia), derived from some fibres on the surface of the aponeurosis, covers the opening.

inner side or pillar; outer pillar; fascia prolonged from margin;

The external ring gives passage in the male to the spermatic cord, and in the female to the round ligament; and in each sex the transmitted part lies on the outer pillar as it passes through, and obtains a covering from the intercolumnar fascia. Through this aperture an inguinal hernia protrudes from the wall of the abdomen.

objects passing through.

The *intercolumnar fibres* (fig. 97) run transversely on the surface of the aponeurosis, and bind together its parallel fibres, so as to construct a firm membrane. Inferiorly, where they are strongest, some well-marked bundles are connected with the outer third of Poupart's ligament, and the anterior end of the iliac crest. At the external abdominal ring the fibres stretch from side to side, and close the upper end of that opening; and as they are prolonged on to the cord from the margin of the ring, they give rise to a membrane named the *intercolumnar* or *spermatic fascia*. On the left side, where the fascia is entire, this thin covering will be manifest on the surface of the cord, or on the round ligament in the female.

Intercolumnar fibres: attachment inferiorly; they produce intercolumnar fascia.

Dissection. To see the attachments and connections of Poupart's ligament, it will be necessary to reflect, on both sides of the body, the lower part of the external oblique aponeurosis towards the thigh. For this purpose an incision is to be carried inwards, through the aponeurosis, from the front of the iliac crest to a spot about three inches from the linea alba; and the tendon is to be detached from the subjacent parts with the handle of the scalpel. When the aponeurosis cannot be separated farther from the tendons beneath, near the linea alba, it is to be cut in the direction of a line descending to the symphysis pubis.

To see insertion of Poupart's ligament, throw down piece of external oblique,

After the triangular piece of the aponeurosis has been thrown towards the thigh, the spermatic cord is to be dislodged from the surface of Poupart's ligament, to see the insertion of the ligament into the pubis, and to lay bare the fibres (triangular fascia) which ascend therefrom to the linea alba.

and show triangular fascia.

Poupart's ligament (fig. 97) is the lower border of the aponeurosis of the external oblique, which is thickened and folded backwards, so as to form a slight groove with the concavity upwards. In the hollow of the ligament the lowest fibres of the internal oblique and transversalis muscles and the cremaster take their origin. Externally it appears round and cord-like, and is attached to the anterior superior iliac spine. Internally it widens as it approaches the pubis, and is inserted into the pubic spine and the pectineal line of the hip-bone for about three-quarters of an inch, forming a triangular piece with

Poupart's ligament: outer and inner attachments; forms Gimbernat's ligament;

its base directed outwards, which is named *Gimbernat's ligament* (fig. 97 and 98).

its direction,

By its lower border Poupart's ligament joins the fascia lata of the thigh; and so long as this membrane remains uncut, the band is curved with its convexity downwards, especially when the limb is extended on the trunk. The outer half of the ligament is oblique, and is firmly united with the subjacent iliac fascia; its inner half is placed over the vessels passing from the abdomen to the thigh.

and parts in contact with it.

Triangular fascia.

Triangular fascia. From the insertion of Gimbernat's ligament into the pectineal line, some fibres are directed upwards and inwards to the linea alba, where they blend with the other tendons. As the fibres ascend, they diverge and form a thin sheet, to which the above name has been given (fig. 97).

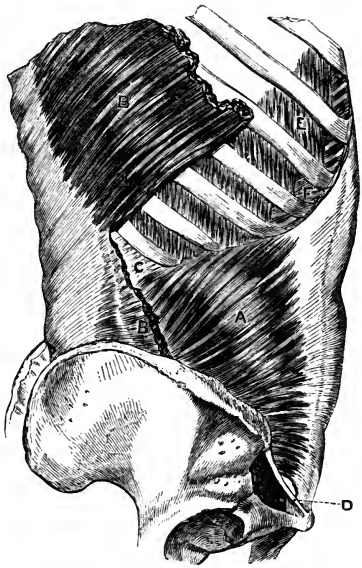


Fig. 99.—The Parts beneath the External Oblique Muscle.

A. Internal oblique muscle.
B. Latissimus dorsi, cut.
C. Part of the hinder tendon of the transversalis muscle.
D. Poupart's ligament.
E. External, F, internal intercostals.

Dissection to expose internal oblique.

Dissection. The upper part of the external oblique is now to be taken away, on both sides of the body, to see the parts beneath. It may be detached by carrying the scalpel through the digitations on the ribs back to the free border, and then through the insertion into the iliac crest. The muscle is to be thrown forwards as far as practicable, after the nerves crossing the iliac crest are dissected out; but in raising it care must be taken not to detach the rectus muscle from the ribs above, nor to cut through the tendon of the internal oblique at the upper part. By the removal of the fatty tissue the underlying internal oblique muscle, with some nerves issuing through it below, will be exposed.

Clean the cremaster.

At the lower border of the internal oblique, where it springs from the deep surface of Poupart's ligament, it will be seen that the fibres are prolonged down upon the spermatic cord. These fibres constitute the *cremaster muscle*, and should be defined. They consist of fleshy loops which descend through the external abdominal ring. Internal to the cord they become tendinous, and are easily taken away.

Parts covered by the external oblique (fig. 99). Beneath the external muscle are the internal oblique, with parts of the ribs and intercostal muscles. At the lower part of the abdomen the muscle conceals the spermatic cord and the branches of the lumbar plexus in the abdominal wall. Parts covered by external oblique.

The INTERNAL OBLIQUE MUSCLE (fig. 99, A) is fleshy at the side and aponeurotic in front, like the preceding; but its fibres (except the lowest) ascend across those of the external oblique. The muscle *arises* from the outer half of Poupart's ligament, from the anterior two-thirds of the crest of the ilium (fig. 47, p. 113), and from the tendon of the transversalis muscle (fascia lumborum, c) in the interval between that bone and the last rib. The fibres diverge on the abdomen to their destination:—The upper ones ascend, and have a fleshy *insertion* into the cartilages of the last three ribs, where they join the internal intercostal muscles of the lowest two spaces. The remaining fibres pass forwards, with varying degrees of obliquity, to end in an aponeurosis. Internal oblique muscle: origin from pelvis; insertion into the ribs and linea alba.

The *aponeurosis* of the muscle extends from the thorax to the pelvis, and is broader above than below. For the most part it is split to encase the rectus (as will be seen when that muscle is exposed); but in the lower half of the space between the umbilicus and pubis it is undivided, and lies altogether in front of that muscle. Along the middle line the two layers are united together, as well as with those of the opposite side, in the linea alba. Superiorly the aponeurosis is arranged in the following manner:—for a short distance before it divides, it is fixed to the ninth costal cartilage; and the posterior of the layers into which it divides continues this attachment along the eighth and seventh cartilages to the ensiform process; while the anterior is prolonged over the chest, blending with the aponeurosis of the external oblique. Inferiorly its fibres become more distinct and are inserted into the front of the pubis, and into the pectineal line for half an inch behind the attachment of Gimbernat's ligament. This lowest part of the aponeurosis is blended with that of the underlying transversalis to form what will be described as the *conjoined tendon* of the two muscles. Aponeurosis divides to enclose rectus, except below; attachments to chest, and pelvis.

Relations. The muscle is covered by the external oblique muscle. It is attached on all sides, except between Poupart's ligament and the pubis, where it arches over the spermatic cord, and has the cremaster muscle continuous with it. The parts covered by the internal oblique will be seen when the muscle is reflected. Parts in contact with internal oblique.

Action. Both muscles depress the ribs, and assist in forcing back the viscera of the belly after they have been protruded by the descent of the diaphragm. Use of both muscles,

One muscle may incline the body laterally; and contracting with the opposite external oblique (the fibres of the two having the same direction), it will rotate the trunk to the same side. of one.

The CREMASTER MUSCLE (fig. 100, D) is a muscular slip which lies along the lower border of the internal oblique, and is named from its suspending the testicle. The muscle is attached both at the inner and Cremaster muscle:

attachments; external fleshy, outer sides, like the lowest fibres of the internal oblique, of which it is essentially a part. Externally it is fleshy, and *arises* from Poupart's ligament, below and in part beneath the internal oblique, with which some of its fibres are connected. Internally it is narrow, and is

internal tendinous; *inserted* by tendon into the front of the pubis, joining the tendon of the internal oblique.

forms loops over the cord, Between the two points of attachment the fibres descend on the front and sides of the cord, forming loops with the convexity downwards as far as, and over, the testis. The bundles of fibres are united by areolar tissue so as to give rise to a covering on the front of the cord, which is named the *cremasteric fascia*. Occasionally the fibres may be behind as well as on the sides and front of the cord.

giving rise to cremasteric fascia;

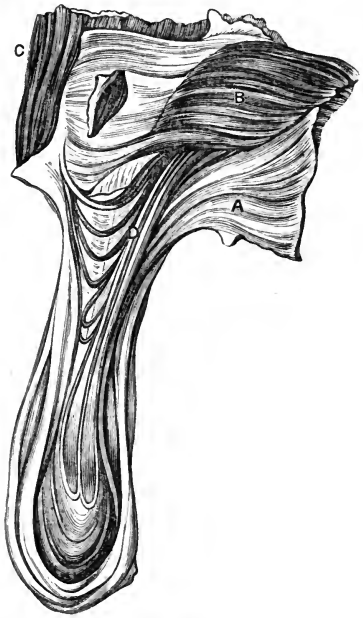


Fig. 100.—The Cremaster. The Lower Part of the Internal Oblique, with the Cremaster Muscle and the Testicle.

A. External oblique, reflected.
B. Internal oblique.
C. Rectus abdominis.
D. Cremaster, with its loops over the spermatic cord and the testicle.

use. *Action.* It elevates the testicle towards the abdomen, and in some cases is under the influence of the will; but it may be excited to contract involuntarily by cold, fear, &c.

It will be remembered that the fascia (tunica dartos) of the scrotum is reinforced by a number of unstriped muscle fibres, and, moreover, that it is connected with the overlying skin. Under the influence of various stimuli (heat, cold, &c.) the unstriped muscle fibres contract, and the scrotal tissues, as well as the coverings of the spermatic cord by the contraction of the cremaster, are puckered up to form a protecting pad in front of the testis, as it lies at the back of the scrotum.

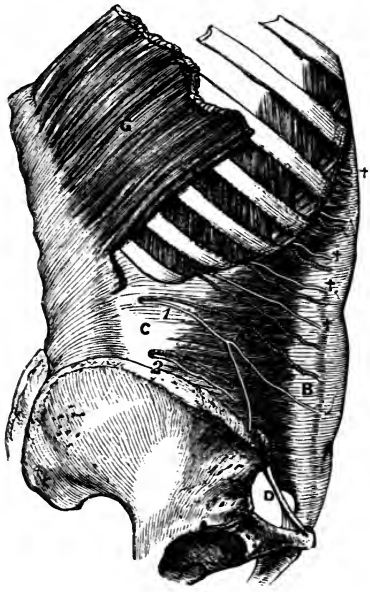
In left groin replace the parts. **Dissection.** On the left side of the body the student is not now to make any further dissection of the abdominal wall; and the layers that have been reflected in the groin should be replaced until the examination of that region is resumed in connection with hernia.

On right side reflect cremaster On the right side the dissection is to be carried deeper by the removal of the internal oblique and the cremaster. The last

muscle may be reflected from the cord by means of a longitudinal incision.

To raise the internal oblique, it will be necessary to cut it through firstly near the ribs, secondly along the crest of the ilium and Poupart's ligament, and lastly at the hinder part, so as to connect the first two incisions. Its depth will be indicated by a fatty layer between it and the transversalis, and by a branch of artery between the two muscles near the anterior superior iliac spine (fig. 106, *b*, p. 287). In raising the muscle towards the edge of the rectus, let the student separate with great care the lower fibres from those of the transversalis with which they are often conjoined, and dissect out, between the two, the intercostal nerves and arteries, and the two branches of the lumbar plexus (ilio-hypogastric and ilio-inguinal) near the fore part of the ilium. The offsets entering the muscle must be cut.

and internal oblique.



Parts covered by internal oblique.

FIG. 101.

A. The Transversalis muscle, with B, its anterior, and C, its posterior tendon (fascia lumborum).
D. Poupart's ligament.
1. Last dorsal nerve with its accompanying artery.
2. Ilio-hypogastric nerve with its artery.
†† Intercostal nerves and arteries.

Parts covered by the internal oblique (fig. 101). The internal oblique conceals the transversalis muscle and the vessels and nerves between the two. Near Poupart's ligament it lies on the spermatic cord and the transversalis fascia. The rectus muscle is covered below by the aponeurosis.

The TRANSVERSALIS MUSCLE (fig. 101, A) forms the third stratum in the wall of the abdomen, and differs from the two oblique muscles in having a posterior as well as an anterior aponeurosis. Like the internal oblique, it is attached on all sides, except where the spermatic cord lies. At the pelvis it *arises* from the outer third of Poupart's ligament and from the anterior two-thirds of the iliac crest along the inner border (fig. 139, p. 369); at the chest it takes origin by fleshy slips from the inner surface of the lower six costal cartilages; and between the chest and the pelvis it is connected with the lumbar vertebræ by means of its posterior aponeurosis, or the

Transversalis muscle:

origin from chest, loins, and pelvis;

fibres end in aponeurosis.

fascia lumborum. All the fibres are directed to the anterior aponeurosis.

The aponeurosis passes behind rectus, except in lower part.

Its *anterior aponeurosis* is widest in the centre, and narrowest at the upper end. Internally it is continued to the linea alba, passing beneath the rectus as low as midway between the umbilicus and the pubis, and in front of the muscle below that spot. Its attachment below to the pelvis is nearly the same as the internal oblique; for it is fixed to the front of the pubis, and to the pectineal line for about an inch. Some of the fibres end on the transversalis fascia, and are connected beneath Poupart's ligament with a thickened band of that fascia which is called the deep crural arch (fig. 97, p. 263).

Fibres to transversalis fascia.

Use.

Action. The transversalis muscle draws downwards the lower ribs, and diminishes the abdominal cavity, compressing the viscera and forcing upwards the diaphragm.

At pelvis unites in conjoined tendon.

Conjoined tendon. The aponeuroses of the internal oblique and transversalis muscles are united near their attachment to the pubis, and give rise to the conjoined tendon. The aponeurosis of the internal oblique extends about half an inch along the pectineal line, while that of the transversalis reaches an inch along the bony ridge and forms the greater part of the conjoined tendon (fig. 102 and fig. 105, p. 286).

Posterior aponeurosis.

The *posterior aponeurosis* of the transversalis, or the fascia lumborum (c), is described in the deep dissection of the back, and it is sufficient here to state that it consists of three layers: *an anterior*, attached to the front of the roots of the lumbar transverse process; a *middle*, attached to their tips; and a *posterior*, attached to the spines of the same vertebræ. The transversalis is chiefly continuous with the middle of these layers and only slightly with the others.

Relations of transversalis muscle.

Relations. Superficial to the transversalis are the two muscles before examined; and beneath it is the thin transversalis fascia. Its fleshy attachments to the ribs alternate with like processes of the diaphragm; and the highest slip joins the lower edge of the triangularis sterni muscle. The lower border of the transversalis is fleshy in the outer, but tendinous in the inner half, and is arched above the internal abdominal ring.

Expose rectus and pyramidalis.

Dissection. Remove the aponeurotic layer from the rectus muscle of the right side, make a longitudinal incision through the tendinous sheath, and turn it to each side. As the sheath is reflected, its union with three or more tendinous bands across the rectus will have to be cut through; and near the pubis a small muscle, the pyramidalis, will be exposed. The dissector should leave the nerves entering the outer border of the rectus.

Leave the left side.

On the left side of the body the rectus should not be laid bare below the umbilicus, in order that the special dissection of the parts concerned in inguinal hernia may be made on this side.

Rectus muscle:

origin from pubis;

The RECTUS MUSCLE (fig. 102, A) extends along the front of the abdomen from the pelvis to the chest. It is narrowest below, where it *arises* from the pelvis by two tendinous processes:—one, the internal and smaller, is attached to the front of the symphysis pubis

in common with that of the opposite side; and the external process springs from the pubic crest. Becoming wider towards the thorax, the rectus is *inserted* by three large fleshy and tendinous slips into the cartilages of the fifth, sixth and seventh ribs, the outermost slip usually extending to the bone of the fifth rib. Some of the inner fibres are often attached to the ensiform process.

insertion into rib-cartilages;

The muscle is contained in an aponeurotic sheath, except above and below; and its fibres are interrupted at intervals by tendinous lines—the *inscriptiones tendineæ*.

has cross tendons;

Action. It will draw down the thorax and the ribs, or raise the pelvis, according as its fixed point may be below or above. Besides imparting movement to the trunk, it will diminish the cavity of the abdomen, and compress the viscera.

use on trunk,

on abdomen.

Sheath of the rectus (D). This sheath is derived from the splitting of the aponeurosis of the internal oblique at the outer edge of the rectus. One piece passes before, and the other behind the muscle; and the two unite at the inner border so as to complete the sheath. Inseparably blended with the stratum in front of the rectus is the aponeurosis of the external oblique; and joined in a similar manner with that behind is the aponeurosis of the transversalis. The anterior layer of the sheath adheres closely to the tendinous intersections of the muscle.

Its sheath:

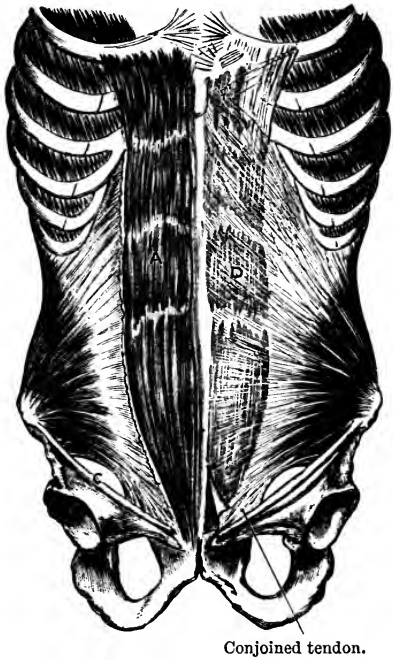


FIG. 102.—THE RECTUS MUSCLE OF THE ABDOMEN.

how formed

The muscle is dissected on the right side, and left in its sheath on the left. Close above the pubes the pyramidalis is exposed.

A. Rectus.
B. Internal oblique.
C. Poupart's ligament.
D. Anterior layer of the sheath of the rectus.

The sheath is deficient behind, both at the upper and lower end of the muscle. Above, the muscle rests on the ribs, without the intervention of the sheath, which is fixed to the margin of the thorax. Below, at, or somewhat above, a point midway between the

deficient above and below.

umbilicus and pubis, the aponeurosis of the internal oblique ceases to split, and then passes altogether in front of the rectus, with the other aponeuroses. When the rectus is raised, the termination of the hinder layer of the sheath is seen to be marked by a more or less distinct white line, concave towards the pubis, which is termed the *semilunar fold of Douglas* (fig. 105, p. 286) : below this the rectus is in contact with the transversalis fascia.

Fold of Douglas.

Lineæ transversæ are three or more; situation.

The *lineæ transversæ* (fig. 102) on the front of the sheath are caused by the tendinous intersections of the rectus. The most constant are three in number, and have the following position ; one is opposite the umbilicus, another at the lower end of the ensiform process, and the third is midway between the two. If there is a fourth it will be placed below the umbilicus. These markings seldom extend the whole depth or breadth of the muscular fibres, more particularly the highest and lowest.

Linea semilunaris is at edge of rectus.

Linea semilunaris (fig. 97, p. 263). This line corresponds with the outer edge of the rectus, and reaches from the cartilage of the ninth rib to the pubic spine of the hip-bone : it marks the line of division of the aponeurosis of the internal oblique muscle.

Pyramidalis muscle : attachments ; use.

The PYRAMIDALIS MUSCLE (fig. 102) is triangular in form, and is placed in front of the lower end of the rectus. It *arises* by its base from the front of the pubis, and is *inserted* into the linea alba below the mid-point between the umbilicus and the pelvis. This small muscle is often absent.

Action. The muscle renders tense the linea alba ; and when large it may slightly assist the rectus in compressing the viscera.

Nerves in wall of abdomen.

NERVES OF THE ABDOMINAL WALL (fig. 101, p. 271, and fig. 97, p. 263). Between the internal oblique and transversalis muscles are situate the intercostal nerves ; and near the pelvis are two branches of the lumbar plexus, viz., the ilio-hypogastric and ilio-inguinal nerves. Some arteries accompany the nerves, but they will be referred to with the vessels of the abdominal wall (p. 283).

Intercostal nerves are between oblique and transversalis ; offsets.

The LOWER FIVE INTERCOSTAL NERVES enter the wall of the abdomen from the intercostal spaces. Placed between the two deepest lateral muscles, the nerves are directed forwards to the edge of the rectus, and through this muscle to the surface of the abdomen near the middle line. About midway between the spine and the linea alba, the nerves furnish cutaneous branches to the side of the abdomen (lateral cutaneous, p. 262) ; and while between the abdominal muscles they supply branches to them and offsets of communication with one another. A greater part of the lower than of the upper nerves is visible, owing to the shortness of the inferior spaces.

Last dorsal nerve.

The LAST DORSAL NERVE (fig. 101[1]) is placed below the twelfth rib, and therefore is not in an intercostal space, but it has a similar course and distribution to the foregoing. As it extends forwards to the rectus it communicates sometimes with the ilio-hypogastric nerve ; and its lateral cutaneous branch perforates the two oblique muscles (p. 263).

The ILIO-HYPOGASTRIC NERVE (2) perforates the back of the transversalis muscle near the iliac crest, and divides into iliac and hypogastric branches. Ilio-hypogastric nerve:

The *iliac branch* pierces both oblique muscles close to the crest of the ilium, to reach the gluteal region (p. 263). iliac part

The *hypogastric branch* is directed forwards above the hip-bone, giving twigs to the transverse and internal oblique muscles, and communicating with the ilio-inguinal nerve. It perforates the fleshy part of the internal oblique near the front of the iliac crest, and the aponeurosis of the external oblique near the linea alba and finally becomes cutaneous in the hypogastric region (p. 264). and hypogastric part.

The ILIO-INGUINAL NERVE perforates the transversalis muscle near the front of the iliac crest. It afterwards pierces the internal oblique, and reaches the surface through the external abdominal ring (p. 264): on its way it furnishes offsets to the internal oblique, the transversalis, and the pyramidalis. Ilio-inguinal nerve.

Dissection. To see the transversalis fascia on the right side, it will be necessary to raise the lower part of the transversalis muscle by two incisions :—one of these is to be carried through the fibres attached to Poupart's ligament; the other, across the muscle from the front of the iliac crest to the margin of the rectus. With a little care the muscle may be separated easily from the thin fascia beneath. Dissection of transversalis fascia.

The TRANSVERSALIS FASCIA is a thin fibrous layer between the transversalis muscle and the peritoneum. In the inguinal region, where it is unsupported by muscles, the fascia is considerably stronger than elsewhere, and is joined by some tendinous fibres of the transversalis muscle; but farther from the pelvis it gradually decreases in strength, until at the thorax it becomes very thin. Transversalis fascia is best marked in the groin;

In the part of the fascia now laid bare is the internal abdominal ring, which gives passage to the spermatic cord, or the round ligament of the uterus, according to the sex; it resembles the hole into the finger of a glove in being visible from within, but not externally, owing to the fascia being prolonged from its margin on to the cord. On the inner side of the ring the fascia is thinner than on the outer, and is fixed to the body of the pubis and to the ilio-pectineal line behind the conjoined tendon, with which it is united. pierced by internal abdominal ring.

Along the outer half of Poupart's ligament the fascia ends by joining the posterior margin of that band, and it will be afterwards seen to unite with the iliac fascia for the same extent, but beneath the inner half of the ligament it is continued downwards to the thigh, in front of the blood-vessels, to form the anterior part of the crural sheath around them. Ending of fascia below.

Internal abdominal ring (fig. 105, p. 286, and fig. 106, p. 287). This opening is situate midway between the symphysis pubis and the anterior superior iliac spine, and half an inch above Poupart's ligament. From its margin a thin tubular prolongation of the transversalis fascia (infundibuliform fascia) is continued around the cord as before said. Situation internal abdominal ring.

Dissection. The tubular prolongation on the cord may be traced Dissection to follow process on cord.

by cutting the transversalis fascia horizontally above the opening of the ring, and then longitudinally over the cord. With the handle of the scalpel the thin membrane may be reflected to each side, so as to lay bare the subperitoneal fat.

Subperitoneal tissue in groin.

The *subperitoneal fat* forms a layer between the transversalis fascia and the peritoneum. Its thickness varies much in different bodies, but is greater at the lower than at the upper part of the abdomen. This structure will be more specially noticed in the examination of the wall of the abdomen from the inside.

Trace remains of peritoneum.

Dissection. After the subperitoneal fat has been seen, let it be reflected to look for the remains of a piece of peritoneum which extends along the cord in the form of a fibrous thread.

Peritoneum of the groin is prolonged on the cord:

The *peritoneum*, or the serous sac of the abdominal cavity, projects forwards slightly opposite the internal abdominal ring. Connected with it at that spot is a fibrous thread (the remains of a prolongation to the testis in the fœtus) which extends a variable distance along

piece may be impervious,

the front of the cord. It is generally impervious, and can be followed only a very short way; but it may sometimes be traced as a fine band to the tunica vaginalis of the testis.

or sacculated,

In some bodies the process may be partly open, being sacculated at intervals; or it may form occasionally a single large bag in front

or open.

of the cord. Lastly, as a rare state, it may remain unclosed as in the fœtus, so that a coil of intestine could descend in it from the abdomen.

In female may be partly open.

In the female the fœtal tube of peritoneum sometimes remains pervious for a short distance in front of the round ligament; the unobliterated portion being called the *canal of Nuck*.

Spermatic cord

The SPERMATIC CORD (fig. 105, p. 286, and fig. 106, F, p. 287) extends from the internal abdominal ring to the testis, and consists mainly of the vessels and efferent duct of the gland, united together by coverings from the structures by or through which they pass.

is oblique in the abdominal wall,

In the wall of the abdomen the cord lies obliquely, since its aperture of entrance amongst the muscles is not opposite its aperture of exit from them; but, escaped from the abdomen, it descends almost

and vertical beyond;

vertically to its destination. In the oblique part of its course it is contained in the passage named the inguinal canal; it is placed at first beneath the internal oblique, and rests against the transversalis

relations;

fascia; but beyond the lower border of the oblique muscle, it lies on the upper surface of Poupart's ligament, with the aponeurosis of the external oblique between it and the surface of the body, and the conjoined tendon behind it.

coverings.

Its several *coverings* are derived from the strata in the wall of the abdomen. Thus, from within outwards are

(1) the subperitoneal fat,
(2) the infundibuliform process of the transversalis fascia,
(3) the cremaster muscle continuous with the internal oblique,
(4) the intercolumnar or spermatic fascia from the external oblique muscle,

and, lastly, the superficial fascia and the skin.

The *round ligament*, or the suspensory cord of the uterus, occupies the inguinal canal in the female, and ends in the integuments of the groin. Its coverings are similar to those of the spermatic cord of the male except that it wants the cremaster. In female round ligament is in place of cord.

THE SPERMATIC CORD AND THE TESTIS.

Dissection. The constituents of the cord will now be displayed by cutting them through longitudinally, as far as the scrotum, and turning aside the different surrounding layers, and removing the areolar tissue. The dissector should trace branches of the genito-crural nerve and deep epigastric artery into the cremasteric covering, and note the passage of the spermatic vessels between the abdomen and the cord at the internal abdominal ring, and define the vas deferens. Dissection.

Vessels and nerves of the cord. In the cord are collected together the spermatic artery and veins, which convey the blood to and from the testicle, the nerves and lymphatics of the testicle, and the vas deferens or the efferent duct. Constituents of the cord.

In the female *a branch from the ovarian artery* enters the round ligament. Vessel in female.

The *vas deferens* reaches from the testicle to the urethra, and is placed behind the other constituents of the cord; it will be recognised by its resemblance in feel to a piece of whipcord, when it is taken between the finger and the thumb. As it enters the abdomen through the opening in the transversalis fascia (internal ring), it lies on the inner side of the vessels of the testicle, and, at the same place, winds behind the epigastric artery. A small artery (*the artery of the vas*) will be seen running along it. It is derived either from the superior or inferior vesical arteries. Vas deferens: situation and course.

Cremasteric artery and nerve. The cremasteric covering of the cord has a separate artery and nerve. The *artery* is derived from the deep epigastric, and is distributed to the coverings of the cord. The *genital branch of the genito-crural nerve* enters the cord by the internal abdominal ring, and ends in the cremaster muscle. Artery and nerve of the coverings of the cord; and cutaneous.

Cutaneous vessels and nerves are supplied to the integuments covering the cord from the superficial external pudic artery and the ilio-inguinal nerve.

Dissection. The spermatic cord and all its coverings should now be cut through at the external abdominal ring and, with the right half of the scrotum and the enclosed testis, removed for examination. The parts should be pinned out on a leaded piece of cork and dissected under water; the different layers being divided by a longitudinal incision and pinned out laterally as they are reflected.

In the meantime the anterior abdominal wall should be carefully covered with cloths soaked in preservative.

The TESTICLES (testes) are the glandular organs for the secretion of the semen. Each is suspended in the scrotum by the spermatic cord and its coverings, but the left is usually lower than the right; and Testes placed in scrotum.

each is provided with an excretory duct named the vas deferens. A serous sac partly surrounds each organ.

To see the serous sac.

Dissection. For the purpose of examining the serous covering of the testicle (tunica vaginalis) make a small aperture into the upper part of the sac when the skin of the scrotum and the superficial coverings have been reflected and inflate it. The sac and the spermatic cord are then to be cleaned; and the vessels of the latter are to be followed to their entrance into the testicle. Finally the tunica vaginalis is to be opened from the front to expose the testis.

Tunica vaginalis

The *tunica vaginalis* (fig. 103, *d*) is a serous bag, which is continuous in the fœtus with the peritoneal lining of the abdomen, but becomes subsequently a distinct sac through the obliteration of the intermediate part.

partly covers the testicle, and lines scrotum:

It invests the testicle after the manner of other serous membranes; for the testicle is placed behind it, so as to be partly enveloped by it. The sac, however, is larger than is necessary for covering the testicle, and projects some distance above it. Like other serous membranes, it has an external rough, and an internal smooth surface; and like them, it has a visceral and a parietal part.

visceral part,

The *visceral layer* (tunica vaginalis testis) covers the testicle, except posteriorly where the vessels lie. On the outer side it extends farther back than on the inner, and invests the greater part of the epididymis, forming a pouch (digital fossa) between that body and the testicle.

and parietal.

The *parietal part* of the sac (tunica vaginalis scroti) is more extensive than the piece covering the testicle, and lines the contiguous layer of the scrotum.

Testicle oval;

Form and position of the testis (fig 103). The testicle is oval in shape, with a smooth surface, and is somewhat compressed from side

margins.

to side. The anterior margin is convex and free; the posterior, is flattened, and is pierced by the spermatic vessels and nerves.

Epididymis.

Stretching like an arch along the outer side is the epididymis (*b*). Attached to the upper end of the testis is a small body (*c*), the

Hydatid of Morgagni.

hydatid of Morgagni, which is the remains of the upper end of the fœtal duct of Müller; and occasionally other smaller projections of the tunica vaginalis are connected with the top of the epididymis.

Suspended obliquely.

The testis is suspended obliquely, so that the upper part is directed forwards and somewhat outwards, and the lower end backwards and rather inwards.

Dimensions,

Size and weight. The length of the testis is an inch and a half or two inches; from before backwards it measures rather more

and weight.

than an inch, and from side to side rather less than an inch. Its weight is nearly an ounce, and the left is frequently larger than the other.

A dense tunic encloses small secreting tubes.

STRUCTURE. The substance of the testicle is composed of minute secreting tubes, around which the blood-vessels are disposed in plexuses. Surrounding and supporting the delicate seminiferous tubes is a dense covering—the tunica albuginea. The excretory, or efferent, duct is the vas deferens.

Dissection. With the view of examining the investing fibrous coat, let the testis be placed on its outer side, viz., that on which the epididymis lies, and let it be fixed firmly in that position with pins. The fibrous coat is to be cut through along the anterior part, and thrown backwards as far as the entrance of the blood-vessels. While raising this membrane a number of fine bands will be seen traversing the substance of the testicle, and a short septal piece (mediastinum) may be perceived at the back of the viscus, where the vessels enter; but it will be expedient to remove part of the mass of tubes from the interior (fig. 104), to bring more fully into view the mediastinum, and to trace back some of the finer septa to it.

How to see the structure of the testis.

The *tunica albuginea*, or the fibrous coat of the testicle, is of a bluish-white colour, and resembles in appearance the sclerotic coat of the eyeball. This membrane protects the secreting part of the testicle, and maintains the shape of the organ by its dense and unyielding structure: it also sends inwards processes to support and separate the seminal tubes. These offsets of the membrane appear in the dissection; and one of them at the back of the testicle, which is larger than the rest, is the mediastinum.

Fibrous coat: characters; use; sends inwards processes, as the mediastinum

The *mediastinum testis* (corpus Highmorianum, fig. 104, *r*,) projects into the gland for a third of an inch with the blood-vessels. It is situate at the back of the testis, extending from the upper nearly to the lower end, and is rather larger and deeper above than below. It is formed of two pieces, which are united in front at an acute angle. To its front and sides the finer septal processes are connected; and in its interior are contained the blood-vessels behind, and a network of seminal ducts (rete testis) in front.

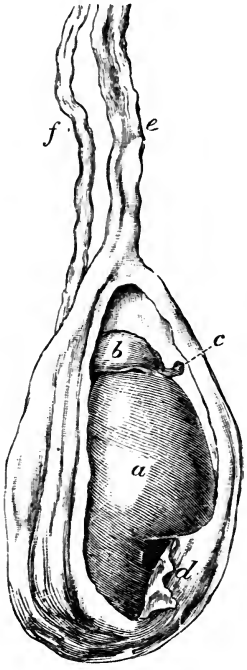


FIG. 103.—THE TESTIS, WITH THE TUNICA VAGINALIS LAID OPEN.

a. Testicle.
b. Globus major of the epididymis.
c. Corpus Morgagni.
d. Parietal part of the tunica vaginalis.
e. Vessels of the spermatic cord.
f. Vas deferens.

Of the *finer processes* of the tunica albuginea (fig. 104, *b*) which enter the testis, there are two kinds. One set, round and cord-like, but of different lengths, is attached posteriorly to the mediastinum, and serves to maintain the shape of the testis. The other set forms delicate membranous septa, which divide the mass of seminal tubes into lobes, and join the mediastinum, like the rest.

and finer septa:

Within the tunica albuginea is a thin vascular layer, the *tunica* a vascular layer lines

it (tunica vasculosa).

vasculosa, which lines the fibrous coat, and covers the different septa in the interior of the gland. It is formed of the ramifications of the blood-vessels, united by areolar tissue, like the pia mater of the brain : in it the arteries are subdivided before they are distributed on the secreting tubes and the small veins are collected into larger trunks.

Secreting tubules : appearance and length ; communications ; and size.

The *seminal tubes* (tubuli seminiferi) are very convoluted, and are but slightly held together by fine areolar tissue and surrounding blood-vessels, so that they may be readily drawn out of the testis for some distance : their length is about two feet and a quarter (Lauth). Within the lobes of the testis some tubes end in distinct closed extremities ; but the rest communicate, forming loops or arches. Their diameter varies from $\frac{1}{100}$th to $\frac{1}{150}$th of an inch. The wall of the tube is formed of a thin translucent membrane, but it has considerable strength.

Tubes change their name.

Names of the different parts of the tubes. To different parts of the seminal tubes, the following names have been applied. Where the tubules are collected into masses, they form the lobes of the testis. As they enter the fibrous mediastinum they become straight, and are named tubuli recti. Communicating in the mediastinum they produce the rete testis. And, lastly, as they leave the upper end of the gland they are convoluted, and are called vasa efferentia, or coni vasculosi.

They form the lobes : number ; shape ;

The *lobes of the testis* (fig. 104, *a*) are formed by bundles of the seminiferous tubes, and are situate in the intervals between the processes of the tunica albuginea. From 100 to 200 in number (Krause), they are conical in form, with the base of each at the circumference, and the apex at the mediastinum testis ; and those in the centre of the testicle are the largest.

tubes in them, and arrangement.

Each is made up of two or more tortuous seminal tubules ; and the minute tubes in one lobe are united with those in the neighbouring lobes. Towards the apex of each lobe the tubules become less bent, and are united together ; and the tubuli of the several lobes are farther joined at the same spot into the tubuli recti.

Tubes next become straight (tubuli recti),

Tubuli recti (fig. 104, *c*). The seminal tubes uniting together become narrower and straighter in direction, and are named tubuli recti or vasa recta : they pierce the fibrous mediastinum and enter the rete testis.

afterwards join together (rete testis),

Rete testis (fig. 104, *e*). In the mediastinum the seminal tubes have no proper walls (beyond epithelium), and are situate in the anterior part, in front of the blood-vessels ; they communicate freely so as to form a network.

and leave the gland as vasa efferentia.

Vasa efferentia (fig. 104, *f*). From twelve to twenty tubes leave the top of the rete, and issue from the upper end of the testicle as the vasa efferentia : these are larger than the tubes with which they are continuous, and end in the canal of the epididymis (part of the common excretory duct). Though straight at first, they soon become convoluted, and form the *coni vasculosi.* In the natural state the coni are about half an inch in length, but when unravelled the

tubes measure six inches; and they join the excretory duct at intervals of about three inches.

The EXCRETORY DUCT receives the vasa efferentia from the upper part of the gland, and extends thence to the urethra. Its first part is in contact with the testis, is very flexuous, and forms the epididymis; the remainder is comparatively straight, and is the vas deferens. Excretory duct in two parts.

The EPIDIDYMIS (figs. 103, *b*, and 104, *h*) extends in the form of an arch along the outer side of the testis, at the back from the upper to the lower end, and receives its name from its situation. Opposite the upper part of the testicle it presents an enlarged portion or head, the *globus major* (*g*); and at the lower end of that organ it becomes more pointed or tail-like—*globus minor* (*i*), before ending in the vas deferens. The intervening narrow part of the epididymis is called the *body* (*h*). The epididymis is attached to the testis, most closely at each end, by fibrous tissue and by the reflection of the tunica vaginalis, the globus major also being attached by the vasa efferentia. Epididymis consisting of head, tail, and body; how fixed;

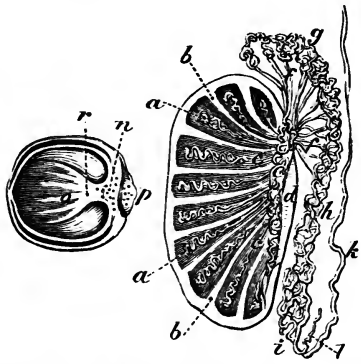


FIG. 104.—VERTICAL SECTION OF THE TESTIS TO SHOW THE ARRANGEMENT OF THE SEPTA AND SEMINAL TUBES.

a. Lobes of the testis.
b. Septa between the lobes.
c. Tubuli recti.
d. Mediastinum testis.
e. Rete testis.
f. Vasa efferentia.
g. Globus major.
h. Body, and *i*, globus minor of the epididymis.
k. Vas deferens.
l. Vas aberrans.

HORIZONTAL SECTION.

n. Rete testis, in section.
o. Finer septa.
p. Epididymis, cut across.
r. Mediastinum, cut across.

The epididymis is formed of a single tube, bent in a zigzag way, the coils of which are united into a solid mass by fibrous tissue. After the removal of the serous membrane and some fibrous tissue this part of the tube may be uncoiled; it then measures twenty feet or more in length. The diameter of its canal is about $\frac{1}{7}$th of an inch, though there is a slight diminution in size towards the globus minor; but it increases again as it approaches the vas deferens. formed of coiled tube; length and size.

The VAS DEFERENS (fig. 104, *k*) begins opposite the lower end of the testis, at the termination of the globus minor of the epididymis. At first the duct is slightly wavy, but afterwards it becomes for the most part a firm, round, and direct tube; near its termination it is enlarged again and sacculated, as will be seen later. Vas deferens:

course to urethra; In its course to the urethra it ascends over the hinder part of the testicle, on the inner side of the epididymis, and then along the blood-vessels of the spermatic cord, with which it enters the internal abdominal ring; here it bends downwards round the epigastric artery, as has already been seen, and is then continued behind the bladder (p. 389), and through the prostate to open into the urethra.

length and size. The length of this part of the excretory duct is about two feet, and the width of its canal about $\frac{1}{12}$th of an inch.

Vas aberrans frequently present: situation, Opening into the vas deferens, at the angle of union with the epididymis, there is frequently a small, narrow, cæcal appendage, the *vas aberrans* of Haller (fig. 104, *l*). It is convoluted, and projects upwards for one or two inches amongst the vessels of the cord.

and size. Like the epididymis, it is longer when it is uncoiled. Its capacity is greatest at the free end.

Three coats form the duct: a fibrous, *Structure.* The vas deferens has a thick muscular coat, which is covered externally by fibrous tissue, and lined internally by mucous membrane. To the feel the duct is firm and wiry, like whip-cord. On a section its wall is dense and of a rather yellow colour.

a muscular, The *muscular coat* is composed of longitudinal and circular fibres arranged in strata. Both externally and internally is a longitudinal layer, the latter being very thin; and between them is the layer of circular fibres.

and a mucous. The *mucous membrane* is marked by longitudinal folds in the straight part of the canal, and by irregular ridges in the sacculated portion.

Organ of Giraldès: remains of Wolffian body. *Organ of Giraldès.* In the spermatic cord of the fœtus and child, and sometimes in the adult, a small whitish, granular-looking body may be recognised, which is named the *organ of Giraldès*, or the *paradidymis*. It consists of several small masses of convoluted tubules which appear to be remnants of the lower part of the Wolffian body.

Spermatic artery. BLOOD-VESSELS AND NERVES OF THE TESTICLE. The branches of the *spermatic artery* supply offsets to the epididymis, and enter the posterior part of the mediastinum. The vessels are finely divided in the vascular structure lining the interior of the tunica albuginea, before being distributed to the lobes of the testis.

Spermatic vein. The *spermatic vein* results from the union of branches issuing from the back of the testicle and the epididymis. As it ascends along the cord its branches form the *spermatic or pampiniform plexus*. On the right side it joins the vena cava, and on the left the renal vein.

Lymphatics The *lymphatics* of the testicle ascend on the blood-vessels, and join the lumbar glands.

and nerves. The *nerves* are derived from the sympathetic, and accompany the artery to the testis.

Vessels of the duct. *Vessels of the vas deferens.* A special *artery* is furnished to the vas from the upper or lower vesical, and reaches as far as the testis, where it anastomoses with the spermatic artery. *Veins* from the *epididymis* enter the spermatic vein. The *nerves* are derived from the hypogastric plexus.

Dissection of the abdominal wall renewed. The dissection of the anterior abdominal wall will now be resumed. By raising the stump of the spermatic cord from over the pubis towards the internal abdominal ring, a fibrous band below Poupart's ligament, the deep crural arch, will appear: it passes inwards to the pubis, and is to be defined with some care. Dissection of deep arch,

The remaining vessels of the abdominal wall, viz., the deep epigastric and circumflex iliac, and the ending of the internal mammary artery, are to be next dissected. The epigastric and mammary arteries will be found on raising the outer edge of the rectus, one at the upper end, and the other at the lower. and of the vessels in the wall of abdomen.

The epigastric, with its earliest branches, may be traced by removing the transversalis fascia from it near Poupart's ligament. The circumflex iliac artery lies behind the outer half of Poupart's ligament, and should be pursued along the iliac crest to its ending.

Deep crural arch (fig. 97, p. 263). Below the level of Poupart's ligament is a thin band of transverse fibres over the femoral vessels, which has received the name deep crural arch from its position and resemblance to the superficial crural arch (Poupart's ligament). This fasciculus of fibres, beginning about the centre of the ligament, is prolonged inwards to the pubis, where it is widened, and is inserted into the pectineal line at the deep aspect of the conjoined tendon of the broad muscles of the abdomen. It is closely connected with the front of the crural sheath.* Deep crural arch: attachments.

VESSELS IN THE WALL OF THE ABDOMEN. On the side of the abdomen are some of the intercostal and lumbar arteries with the nerves. In the sheath of the rectus lie the deep epigastric and internal mammary vessels. And running along the crest of the ilium is the circumflex iliac branch. Vessels in abdominal wall.

The INTERCOSTAL ARTERIES of the lowest two spaces issue between the corresponding ribs, and enter the abdominal wall between the transversalis and internal oblique muscles: they extend forwards with the nerves, supplying the contiguous muscles, and forming anastomoses with the internal mammary, epigastric and lumbar arteries. Intercostal arteries.

LUMBAR ARTERIES. The anterior branches of the lumbar arteries supply the muscles in the hinder part of the abdominal wall, and anastomose with the foregoing arteries above, with the circumflex iliac and ilio-lumbar arteries below. The highest artery accompanies the last dorsal nerve below the twelfth rib, and is distributed with the nerve. From the lowest lumbar artery a branch passes to the integuments with the iliac part of the ilio-hypogastric nerve. Lumbar arteries.

INTERNAL MAMMARY ARTERY. The abdominal branch of this vessel is called the superior epigastric, and enters the wall of Superior epigastric artery.

* Sometimes this structure is a firm distinct band, which is joined by some of the lower fibres of the aponeurosis of the external oblique. At other times, and this is the most common arrangement, it is only a thickening of the transversalis fascia, with fibres added from the tendon of the transversalis muscle.

the abdomen beneath the cartilage of the seventh rib. Descending in the sheath of the rectus, it soon enters the substance of the muscle, and anastomoses in it with the epigastric artery. Branches are given to the neighbouring muscles and the overlying integument.

Inferior or deep epigastric artery:

The DEEP EPIGASTRIC ARTERY (fig. 106, *a*, p. 287) arises from the external iliac about a quarter of an inch above Poupart's ligament; it ascends in the sheath of the rectus, and above the umbilicus divides into branches which enter that muscle, and anastomose with the superior epigastric.

relations in wall of abdomen.

As the artery courses to the rectus it passes beneath the spermatic cord (or round ligament of the uterus), and on the inner side of the internal abdominal ring; and it is directed obliquely inwards across the lower part of the abdomen, so as to form the outer boundary of a triangular space along the edge of the rectus. It lies at first beneath the transversalis fascia; but it soon perforates that membrane, and enters the sheath of the rectus over the semilunar fold of Douglas.

Branches:

The *branches* of the artery are numerous, but small in size:—

pubic joins obturator;

a. The *pubic branch* is a small artery, which runs transversely behind Poupart's ligament to the back of the pubis, where it anastomoses with the similar branch of the opposite side, and with an offset from the obturator artery (fig. 107, *f*, p. 294). The size of the anastomosis with the obturator artery varies very much, but it is often so large that the obturator artery is derived wholly or in part from the deep epigastric through the enlargement of its pubic branch, giving rise to the commonest form of an *abnormal obturator artery.*

cremasteric;

b. A *cremasteric branch* is furnished to the muscular covering of the cord.

muscular;

c. Muscular branches are given from the outer side of the artery to the abdominal wall, and anastomose with the intercostal and lumbar arteries; others enter the rectus.

cutaneous.

d. Cutaneous offsets pierce the muscle, and ramify in the integuments with the anterior cutaneous nerves.

Epigastric veins.

Two *epigastric veins* lie with the artery; they join finally into one, which opens into the external iliac vein.

Circumflex iliac artery

The DEEP CIRCUMFLEX ILIAC ARTERY arises from the outer side of the external iliac, opposite, or a little below the deep epigastric. It runs at first over the iliacus, close behind Poupart's ligament, in a fibrous sheath at the junction of the iliac and transversalis fasciæ, and then along the inner margin of the iliac crest to about the middle, where it ends by anastomosing with the iliac branch of the iliolumbar artery.

offsets,

Branches. Near the front of the iliac crest a branch (fig. 106, *b*, p. 287) ascends between the internal oblique and transversalis

muscular,

muscles, supplying them, and anastomosing with the epigastric and lumbar arteries.

As the vessel extends backwards it gives lateral offsets, which supply the neighbouring muscles, and communicate on the one side with the ilio-lumbar, and on the other with the gluteal artery. and anastomotic.

The *deep circumflex iliac vein* is formed by the junction of two collateral branches, and crosses the external iliac artery nearly an inch above Poupart's ligament, to open into the external iliac vein. Circumflex iliac vein.

Section II.

HERNIA OF THE ABDOMEN.

The lower part of the abdominal wall, which has been reserved on the left side of the body, should now be dissected for inguinal hernia. Inguinal hernia.

Dissection. The integuments and the aponeurosis of the external oblique having already been reflected, the necessary dissection of the inguinal region will be completed by raising the internal oblique muscle as in fig. 106. The dissection in the left groin.

To raise the internal oblique muscle, let one incision be made across the fleshy fibres from the iliac crest towards the linea alba; and after the depth of the muscle has been ascertained by the layer of areolar and fatty tissue beneath it, let the lowest fibres be carefully cut through at their attachment to Poupart's ligament. By lifting up the muscle cautiously, the student will be able to separate it from the subjacent transversalis so that it may be turned inwards on the abdomen. The separation of the two muscles just mentioned is often difficult in consequence of their lowest fibres being blended together, but a branch of the deep circumflex iliac artery serves as a guide to the intermuscular interval. Reflect internal oblique.

The cremaster muscle is next to be divided along the cord, and to be reflected to the sides. Let the dissector then clean the surface of the transversalis muscle, without displacing its lower arched border, and define with care the conjoined tendon of it and the internal oblique to show its exact extent. The transversalis fascia and the spermatic cord should also be nicely cleaned. Cut the cremaster. Clean subjacent parts.

Crossing the interval below the border of the transversalis muscle are the deep epigastric vessels, which lie close to the inner side of the internal abdominal ring, but beneath the transversalis fascia. A small piece of the fascia may be cut out to show the vessels. Show the epigastric vessels.

Inguinal Hernia. A protrusion of intestine or other organ through the lower portion of the abdominal wall near Poupart's ligament (answering to the inguinal region) is named an inguinal hernia. The escape of the intestine in this region is favoured by the deficiencies in the muscular strata, by the passage of the spermatic cord through the abdominal parietes and by the existence of fossæ on the inner surface of the wall. Situation of inguinal hernia. Predisposition naturally.

The gut in leaving the abdomen either passes through the internal abdominal ring with the cord, or is projected through the part of Course it follows.

Two kinds :

external or oblique ;

the abdominal wall between the epigastric artery and the edge o the rectus muscle. These two kinds of hernia are distinguished by the names external and internal, from their position to the deep epigastric artery ; or they are called oblique and direct, from the direction they take through the abdominal wall. Thus, the hernia protruding through the internal abdominal ring with the cord is called *external* from being outside the artery, and *oblique* from its slanting course ; while the hernia between the edge of the rectus

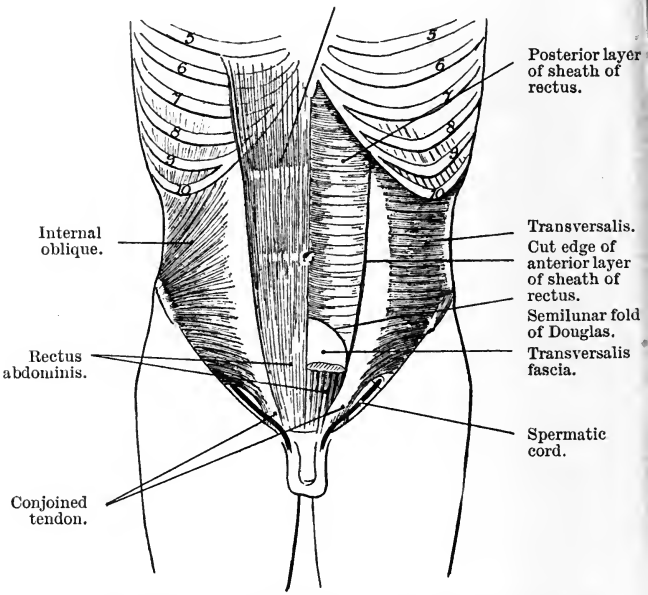


FIG. 105.—DIAGRAM OF THE INTERNAL OBLIQUE AND TRANSVERSALIS MUSCLES, WITH THE SHEATH OF THE RECTUS.

internal or direct.

and the deep epigastric artery is named *internal* from being inside the artery, and *direct* from its straight course.

External or oblique.

EXTERNAL or OBLIQUE INGUINAL HERNIA leaves the cavity of the abdomen with the spermatic cord, and traversing the inguinal canal, makes its exit from that passage by the external abdominal ring.

Anatomy of parts concerned.

ANATOMY OF EXTERNAL HERNIA. To understand the anatomy of this form of hernia, it will be necessary to study the passage which it occupies in its course through the abdominal wall (inguinal canal), the apertures by which it enters and leaves the wall (abdominal rings), and the coverings it receives in its progress.

Inguinal canal :

The INGUINAL CANAL (figs. 105 and 106) is the interval between the flat muscles of the abdominal wall, which contains the spermatic cord in the male, and the round ligament of the uterus in the female.

It extends from the internal to the external abdominal ring, and measures about one inch and a half in length. From its beginning at the internal ring, it is directed obliquely downwards and inwards, being placed above, and nearly parallel to, the inner half of Poupart's ligament. extent, length and direction;

Its *anterior wall* is formed by (1) the integuments and (2) by the aponeurosis of the external oblique muscle (fig. 106) for walls in front,

Fig. 106.—Dissection for Inguinal Hernia (Illustrations of Dissections).

Muscles, &c.:

A. External oblique tendon, thrown down.
B. Internal oblique, the lower part raised.
C. Cremaster muscle in its natural position.
D. Transversalis muscle with a free border.
F. Spermatic cord, surrounded by the infundibuliform fascia.
G. Transversalis fascia.
H. Conjoined tendon.

Arteries:

a. Epigastric.
b. Offset of the circumflex iliac.

its whole extent, and (3) by the internal oblique in its outer third. and behind;

Its *posterior wall* is formed by (1). the peritoneum, sub-peritoneal tissue and transversalis fascia (G) throughout its whole length, (2) by the conjoined tendon (H) of the internal oblique and transversalis muscles in its inner two-thirds, and (3) by the triangular

fascia derived from the external oblique behind the external abdominal ring (fig. 97, p. 263).

floor, and roof.

Its *floor* is formed (1) by the meeting of the transversalis fascia with Poupart's ligament, and (2) by the fibres of Poupart's ligament inserted into the pectineal line (Gimbernat's ligament). Its *roof* is formed (1) by the meeting of its anterior and posterior walls, and (2) by the lower arched borders of the internal oblique and transversalis.

Canal in the female.

In the female, the canal has the same boundaries, but is usually somewhat longer and narrower. In that sex it lodges the round ligament.

Internal abdominal ring: situation, form and margin;

The *internal abdominal ring* (fig. 106) is an aperture in the transversalis fascia, which is situate midway between the symphysis pubis and the anterior superior iliac spine, and half an inch above Poupart's ligament. It is oval in form; and its longest diameter, which is directed vertically, measures about half an inch; the fascia at its outer and lower parts is stronger than at the opposite sides.

relations;

Arching *above* and on the inner side of the aperture is the lower border of the transversalis muscle (D), which is fleshy in the outer but tendinous in the inner half. *Below* is Poupart's ligament, which separates the aperture from the external iliac artery. On the *inner* side its limit is best marked, being formed by the deep epigastric vessels.

parts transmitted through it.

This opening in the transversalis fascia is the inlet to the inguinal canal, and through it the cord, or the round ligament, passes into the wall of the abdomen. An external hernia enters the canal at the same spot, and all the protruding parts receive as a covering the prolongation (infundibuliform fascia) from the fascial margin of the opening.

External abdominal ring: situation.

The *external abdominal ring* (fig. 97) is the outlet of the inguinal canal, and through it the spermatic cord reaches the surface of the body. This aperture is placed in the aponeurosis of the external oblique muscle, near the crest of the pubis; and from the margin a prolongation (spermatic fascia) is sent on the parts passing through it (p. 267).

COURSE AND COVERINGS OF AN EXTERNAL, OR OBLIQUE HERNIA.

The intestine, following the course of the cord,

A piece of intestine leaving the abdomen with the cord, and passing through the inguinal canal to the surface of the body, will obtain a covering from every stratum of the wall of the abdomen in the groin, except from the transversalis muscle.

has coverings of the peritoneum and fat, transversalis fascia, cremaster, spermatic fascia, superficial fascia and skin;

It therefore receives its investments in this order:—As the intestine is thrust forwards, it carries before it first the peritoneum and the subperitoneal fat, and enters the tube of the infundibuliform fascia around the cord. Still increasing in size, it is forced downwards to the lower border of the internal oblique muscle, where it has the cremasteric fascia applied to it. The intestine is next directed along the front of the cord to the external abdominal ring, and in passing through that opening receives the investment of the intercolumnar or spermatic fascia. Lastly, as the hernia descends towards

the scrotum, it has the additional coverings of the superficial fascia and the skin.

In a hernia which has passed the external abdominal ring, the coverings from without inwards are therefore the following :—the skin and superficial fascia, the spermatic and cremasteric fasciæ the infundibuliform fascia, the subperitoneal tissue, and the peritoneum or hernial sac. Two of the coverings, viz., the peritoneal and subperitoneal, originate as the gut protrudes ; but the rest are ready formed round the cord, and the intestine slips inside them. The different layers become much thickened in a hernia that has existed for some time.

seven in number ; how produced.

Diagnosis. If the hernia is small, and is confined to the wall of the belly, it gives rise to an elongated swelling along the inguinal canal. If it has proceeded farther, and entered the scrotum, it forms a flask-shaped tumour with the large end below, and the narrow neck occupying the inguinal passage.

How to distinguish it.

Should a hernia of this kind become strangulated, the seat of stricture is placed usually at the internal abdominal ring, and may be produced either by a constricting fibrous band outside the narrowed neck of the tumour, or by a thickening and contraction of the peritoneum itself at the inner surface of the neck.

Stricture : where situate.

Division of stricture. In division of the stricture, with the view of avoiding the surrounding vessels, the cut is directed upwards on the front and mid-part of the hernia.

To relieve.

Varieties of external hernia. There are two varieties of oblique inguinal hernia that may be mentioned (congenital and infantile), in addition to the ordinary acquired type above described ; they are distinguished by the condition of the peritoneal covering.

Two varieties.

Congenital hernia. This kind is found for the most part in the infant and the child, though it may occur in the adult male. In it the tube of peritoneum (processus vaginalis), which receives the testicle in the fœtus, remains unclosed and the intestine descends into a sac already formed for its reception.

Congenital hernia : how constituted.

Infantile or *encysted hernia* is much rarer than congenital, and cannot be distinguished from the common external hernia during life. It was first recognised in the young child, and received its name of infantile from that circumstance ; but it may be met with at any period of life.

Infantile hernia :

This form of hernia occurs when the fœtal processus vaginalis of the peritoneum is closed only in the neighbourhood of the internal abdominal ring, instead of being obliterated from that point down to the testicle, so that a large serous sac will be situate in front of the spermatic cord, and may occupy the inguinal canal. With this state of the peritoneum, should an external hernia with its coverings descend along the cord in the usual way, it will pass behind the unobliterated sac, like a viscus in a serous membrane. In this way there will be two sacs, an anterior (the tunica vaginalis) containing serum, and a posterior enclosing the intestine.

how constituted.

An infantile hernia is first recognised during an operation by

the knife opening the tunica vaginalis before the sac of the hernia.

Internal hernia.

INTERNAL or DIRECT INGUINAL HERNIA escapes on the inner side of the deep epigastric artery, and has a straight course through the abdominal parietes. Its situation and coverings, and the seat of stricture, will be understood after the examination of the part of the abdominal wall through which it passes.

Triangle of Hesselbach: boundaries;

ANATOMY OF INTERNAL HERNIA. In the abdominal wall near the pubis is a triangular space to which the name of *Hesselbach's triangle* has been given. This is bounded by the deep epigastric artery externally, the outer edge of the rectus muscle internally, and the inner

size;

part of Poupart's ligament below; it measures about two inches from above down, and one inch and a half across at the base.

constituents of wall;

The constituents of the abdominal wall in this area are—the integuments, the muscular strata, and the layers lining the interior of the abdomen, viz., transversalis fascia, subperitoneal tissue, and peritoneum. The muscles have the following arrangement:—The

and disposition of muscles.

aponeurosis of the external oblique is pierced by the external abdominal ring, towards the lower and inner angle of the space. The internal oblique and transversalis, which come next, are united together in the conjoined tendon; and as this descends to its insertion into the pectineal line it covers the inner two-thirds (about an inch) of the space, and leaves uncovered about half an inch between its outer edge and the epigastric vessels, where the transversalis fascia appears.

Hernia in this space of two kinds.

Any intestine protruding in this spot must make a new path for itself, and elongate the different structures, since there is not any passage by which it can descend, like an external hernia. Further, the coverings of the hernia, and its extent and direction in the abdominal wall, must vary according as the gut projects through the portion of the space covered by the conjoined tendon, or through the part external to that tendon.

Coverings of the more common kind are

Course and coverings of the hernia. The commoner kind of internal hernia passes through the part of the triangular space which is covered by the conjoined tendon.

peritoneum and subjacent tissue, transversalis fascia, conjoined tendon,

The intestine in protruding carries before it the peritoneum, the subperitoneal fatty membrane, and the transversalis fascia; next it elongates the conjoined tendon, or, in the case of a sudden rupture, separates the fibres and escapes between them. It then advances into the lower part of the inguinal canal, opposite the external abdominal ring, and passes through that opening on the inner side of the cord, receiving at the same time the covering of the spermatic fascia. Lastly, it is invested by the superficial fascia and the skin.

spermatic fascia, superficial fascia, and skin.

In number the coverings of an internal hernia are the same as those of an external; and in kind the only differences are that the covering of transversalis fascia is not furnished by the infundibuliform process, and the conjoined tendon is substituted for the cremasteric fascia.

The position of the openings in the abdominal wall, and the

straightness of its course, should be kept in mind during attempts to reduce this kind of hernia.

Diagnosis. This rupture will be distinguished from external hernia by its straight course through the abdominal wall, and by the neck being placed close to the pubis, but when an inguinal hernia has attained a large size, it is impossible to tell by an external examination whether it began originally in the triangular space, or at the internal abdominal ring; for as an external hernia increases, its weight drags the internal ring inwards into a line with the external, and in this way the swelling acquires the appearance of a direct rupture. How known from external: impossible if it is large.

Seat of stricture. The stricture in this form of hernia occurs most frequently outside the neck of the tumour, at the opening that has been formed in the conjoined tendon, though it may be inside from thickening of the peritoneum; and it may occasionally be found at the external abdominal ring. Stricture: situation;

In dividing the stricture of a large rupture which appears to be direct, the cut should be made directly upwards in the middle of the front of the tumour, so as to avoid the deep epigastric vessels, the position of which cannot be ascertained. in large hernia.

Variety of internal hernia. Another kind of internal hernia (superior) occurs through that part of the area of the triangular space which is external to the conjoined tendon. The intestine protrudes through the wall of the abdomen close to the deep epigastric artery, and descends along nearly the whole of the inguinal canal to reach the external abdominal ring; so that the term "direct" would not apply strictly to this form of internal hernia. Rarer kind of internal hernia is oblique in direction with the cord.

Coverings. As the gut traverses nearly the whole of the inguinal canal, it has the same coverings as an external hernia. Coverings are same as in external hernia.

Division of the stricture. From an inability to decide always in the living body whether a small hernia is internal or external, the rule observed in dividing the stricture of the neck of the sac is, to cut down upon the mid-part of the tumour; and if it is necessary to open the peritoneum, to cut directly upwards, as in the other kinds of inguinal hernia. Division of stricture.

UMBILICAL HERNIA, or exomphalos, is a protrusion of the intestine through or by the side of the umbilicus. It is very variable in size, and its course is straight through the abdominal wall. Umbilical hernia: course;

Coverings. The coverings of the intestine are—the skin and superficial fascia, a prolongation from the tendinous margin of the aperture in the linea alba, together with coverings of the transversalis fascia, the subperitoneal fat, and the peritoneum. Over the end of the tumour the superficial fascia blends with the other contiguous structures, and its fat disappears. coverings become united over the tumour,

If the hernia is suddenly produced, it may want the investment otherwise derived from the edge of the umbilicus. changes in;

Seat of stricture. The stricture on the intestine is generally at the margin of the tendinous opening in the abdominal wall; and it may be either outside, or in the neck of the sac, as in the other kinds of stricture, where found.

hernia. It should be remembered that the narrowed neck is at the upper end and not in the centre of the swelling.

Other abdominal herniæ are femoral, obturator, sciatic.

Other Forms of Hernia. At each of the other apertures in the parietes of the abdomen, a piece of intestine may be protruded, so as to form a hernia. For instance, there may be *femoral hernia* below Poupart's ligament, with the femoral vessels; *obturator hernia* through the thyroid foramen, with the artery of the same name; and *sciatic hernia* through the sciatic notch.

The femoral hernia, as the most important, will be noticed presently; but the student will refer to special treatises for detailed information respecting the herniæ.

Dissection to open abdomen.

Dissection. *The abdomen is now to be opened* to see the cords and depressions on the posterior surface of the wall. A transverse cut may be made through the umbilicus across the front of the abdomen; and on holding up the lower half of the wall, three prominent fibrous cords, the urachus and the obliterated hypogastric arteries, will be seen ascending to the umbilicus from the pelvis.

Cords on the abdominal wall.

Cords on the abdominal wall. In the middle line is the urachus, which reaches from the summit of the bladder to the umbilicus; on each side is the obliterated hypogastric artery, extending from the side of the pelvis to the umbilicus; and a little external to the last, near Poupart's ligament, is a less marked prominence of the peritoneum caused by the deep epigastric artery.

Three inguinal fossæ:

Fossæ. With this disposition of the cords, three hollows (*inguinal fossæ*) are seen near Poupart's ligament, one internal to the obliterated hypogastric artery, another outside the deep epigastric artery, and the third between the two. The

external,

external fossa corresponds by its lower and inner part to the internal abdominal ring, opposite which there is often a slight depression or dimple of the peritoneum, and is the place where an external inguinal hernia begins to protrude. The

internal,

internal fossa is between the obliterated hypogastric artery and the urachus; its outer part is opposite the external abdominal ring, and is the seat of the commoner (inferior) variety of internal hernia.

and middle.

The *middle fossa* is the smallest, and is placed behind the inguinal canal; in it the superior variety of internal hernia leaves the abdominal cavity.

In some bodies the obliterated hypogastric artery is close to, or behind, the epigastric artery; and in that case the middle fossa will be wanting.

Situation of femoral hernia.

Femoral Hernia. In this hernia the intestine leaves the abdomen below Poupart's ligament, and descends in the membranous sheath around the femoral vessels. Only so much of the structures will be described here as can be now seen; the rest have been noticed fully in the dissection of the thigh (pp. 143 *et seq*).

Dissection of the parts concerned.

Dissection. The dissection for femoral hernia is to be made on the left side of the body.

Divide wall,

The lower portion of the abdominal wall is to be divided from the umbilicus to the pubis, the cut being made on the left side of the urachus, and care being taken not to injure the bladder, which may

project above the pubic bones. The peritoneum is to be detached from the inner surface of the flap, and from the iliac fossa. The layer of subperitoneal fatty tissue is to be separated in the same way, and in doing this the spermatic vessels and vas deferens will come into view as they meet at the internal abdominal ring to form the spermatic cord. Beneath these the external iliac vessels are to be cleaned, with some lymphatic glands lying along them, and the genito-crural nerve on the artery. (In the female the round ligament of the uterus is seen entering the internal abdominal ring round the epigastric artery; while the ovarian vessels cross the external iliac trunks above this dissection.) Any loose tissue remaining is to be taken away to show the beginning of the crural sheath around the femoral vessels, and the interval (crural ring) on their inner side (fig. 107).

detach peritoneum and fat, and clean iliac vessels.

Afterwards the transversalis and iliac fasciæ are to be traced to Poupart's ligament, to see the part that each takes in the formation of the crural sheath.

ANATOMY OF FEMORAL HERNIA. The membranes concerned in femoral hernia are the peritoneum, the subperitoneal fatty layer, the transversalis and iliac fasciæ lining the interior of the abdominal cavity, with the sheath on the femoral vessels to which they give origin at Poupart's ligament.

Anatomy of the structures.

The *peritoneum* lines the inner surface of the abdominal wall, whence it is prolonged without interruption into the iliac fossa and the pelvis; and its thinness and weakness are apparent now it is detached.

Peritoneal layer.

The *subperitoneal fat* extends as a continuous layer beneath the peritoneum, but is thickest and most fibrous at the lower part of the abdomen, where the iliac vessels pass under Poupart's ligament. At that spot it extends over the upper opening of the membranous sheath around the vessels, and covers the space of the crural ring internal to the vein.

Subperitoneal fat, forms septum crurale.

The part of this layer which stretches over the crural ring is named the *septum crurale;* and a lymphatic gland is generally attached to its under-surface.

The *transversalis fascia* has been before noticed (p. 275). At Poupart's ligament it joins the iliac fascia outside the situation of the external iliac artery; but internal to that spot it is continued downwards to the thigh in front of the femoral vessels, and forms the anterior part of the crural sheath.

Transversalis fascia.

The *iliac fascia* covers the ilio-psoas muscle, and lies beneath the iliac vessels. At Poupart's ligament it joins the transversalis fascia external to the iliac vessels; but behind the vessels it is prolonged into the posterior part of the crural sheath.

Iliac fascia.

The *crural sheath* is a loose membranous tube, which encloses the femoral vessels as they enter the thigh, and is obtained from the fasciæ lining the abdomen. Its anterior half is continuous with the transversalis fascia, and its posterior is derived from the iliac fascia and the pubic fascia of the thigh. The sheath is not entirely filled

Sheath on femoral vessels.

by the vessels, for a space (crural canal) exists on the inner side of the vein, through which the intestine descends in femoral hernia. The aperture leading into the crural canal is called the crural ring.

Crural ring: size and boundaries

The *crural ring* (fig. 107) is an interval at the base of the sheath, to the inner side of the femoral vein, and is about half an inch wide, being filled by a lymphatic gland. Bounding it internally are Gimbernat's ligament and the conjoined tendon; and limiting it externally is the femoral vein (*b*). In front is Poupart's ligament, with the deep crural arch; and behind is the pubis, covered by the pectineus muscle and the pubic portion of the fascia lata. Crossing the front of the space, but at some little distance from it, is the spermatic cord in the male, and the round

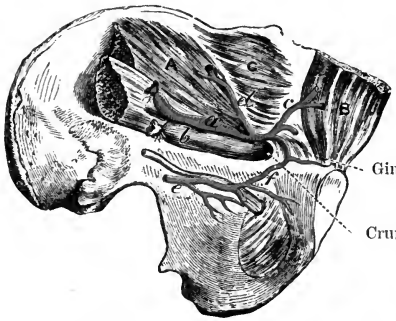


FIG. 107.—INNER SURFACE OF THE OS INNOMINATUM, SHOWING A VIEW OF THE PARTS CONCERNED IN FEMORAL HERNIA (R. QUAIN).

Muscles, &c.:

A. Iliacus covered by the iliac fascia.
B. Rectus.
C. Transversalis, covered by the transversalis fascia.
D. Crural ring.
E. Gimbernat's ligament.

Vessels:

a. External iliac artery.
b. Iliac vein.
c. Deep epigastric artery.
d. Deep circumflex iliac.
e. Obturator artery, with its nerve.
f. Anastomosis between the pubic branches of the obturator and epigastric arteries.

ligament in the female. The opening is larger in the female than in the male.

Constricting boundaries, how relaxed.

Two of the boundaries, anterior and inner, are firm and sharp-edged, though their condition varies with the position of the limb; for if the thigh is raised and approximated to its fellow, those bounding parts will be relaxed.

Usual vessels around ring.

Position of vessels around the ring (fig. 107). On the outer side is the femoral vein (*b*); and above this are the deep epigastric vessels (*c*). In front is a small branch (pubic) from the epigastric artery to the back of the pubis; and the vessels of the spermatic cord may be said to be placed along the anterior aspect of the ring.

Unusual state of vessels.

But in some bodies the obturator artery takes origin from the deep epigastric by an enlargement of its communication (*f*) with the

pubic branch of that vessel, and lies along the ring as it passes to the pelvis. It may have two positions with respect to the crural ring: either it is placed close to the iliac vein, so as to leave the inner side of that space free from vessels; or it arches over the aperture, descending on the inner side at the base of Gimbernat's ligament; in this last condition the ring will be encircled by vessels except behind.

Femoral hernia.

Course of femoral hernia. The intestine leaves the abdomen by the opening of the crural ring; and it descends internal to the vein in the crural sheath, as far as the saphenous opening in the thigh, where it projects to the surface.

Coverings, six in number.

Coverings. In its progress the intestine will push before it the peritoneum and subperitoneal fat (septum crurale); and it will displace the gland which fills the crural ring. Having reached the level of the saphenous opening, the intestine carries before it the inner side of the crural sheath, and a layer called the cribriform fascia; and, lastly, it is invested by the superficial fascia and skin of the thigh. The dissection of the thigh may be referred to for fuller details (pp. 143—146).

Stricture either at neck, or at saphenous opening.

Seat of stricture. The stricture of a femoral hernia is placed opposite the base of Gimbernat's ligament, or lower down at the margin of the saphenous opening in the thigh. And the constriction may be caused either by a fibrous band outside the upper narrow end of the tumour, or by the thickening of the peritoneum inside the neck, as in inguinal hernia.

Incision to divide external

Division of the stricture. To free the intestine from the constricting fibrous band arching over it, an incision is to be made down to the neck of the sac at the inner and upper part.

and internal stricture.

And to relieve the deep stricture within the neck of the sac, the peritoneal bag is to be opened and a director introduced, and the knife is to be carried horizontally inwards, or upwards and inwards, through the thickened sac and a few fibres of the edge of Gimbernat's ligament.

Risk of wounding vessels in regular

Danger to vessels. When the incision is made upwards and inwards to loosen the constricting band in the neck of the tumour, there will not be any vessel injured unless the cut should be made so long as to reach the spermatic cord in the male, or the small pubic branch of the epigastric artery.

and irregular condition of them.

And when the incision is made directly inwards with the same view, there is not usually any vessel in the way of the knife. But in some few instances (once in about eighty operations, Lawrence) the obturator artery takes its unusual course in front, and on the inner side of the neck of the hernia, and will be before the knife in the division of the stricture. As this condition of the vessel cannot be recognised beforehand, the surgeon will best avoid the danger of wounding the artery by a cautious and sparing use of the knife.

Section III.

CAVITY OF THE ABDOMEN.

Definition, and contents.

The abdominal cavity comprises the *abdomen proper* and the *pelvis*, and is the space included between the spinal column behind and the muscles stretching from the thorax to the pelvis in front. It is lined by a serous membrane (peritoneum), and contains the digestive, urinary, and generative organs, with vessels and nerves.

Dissection to open abdomen.

Dissection. To prepare the cavity for examination, the remainder of the abdominal wall above the umbilicus is to be divided, along the left side of the linea alba, as far as the ensiform process. The resulting flaps may be thrown to the sides.

Is largest cavity in the body.

Size and form. This cavity is the largest in the body. It is ovoidal in form, with the ends upwards and downwards, so that it measures more in the vertical than the transverse direction ; and it is much wider above than below.

Boundaries above and below,

Boundaries. Above it is limited by the diaphragm, below by the recto-vesical fascia, the levatores ani muscles and by the other structures closing the outlet of the pelvis. Both these boundaries are concave towards the cavity, and are in part fleshy, so that the space will be diminished by their contraction and flattening.

in front and on sides,

In front and on the sides the parietes are partly osseous and partly muscular ;—thus, towards the upper and lower limits is the bony framework of the skeleton, viz., the ribs in one direction and the pelvis in the other ; but between these the wall is formed by the broad muscles which have been examined already.

and behind.

Behind is placed the spinal column with the muscles contiguous to it, viz., the psoas and the quadratus lumborum.

Depth is altered by action of diaphragm and levatores ani,

Alterations in size. The dimensions of the cavity are influenced by the varying conditions of the boundaries. Its depth is diminished by the contraction and descent of the diaphragm, and the contraction and ascent of the levatores ani ; and the cavity is restored to its former dimensions by the relaxation of those muscles.

width by muscles in wall of abdomen.

The width is lessened by the contraction of the abdominal muscles ; but it is increased, during their relaxation, by the action of the diaphragm forcing outwards the viscera.

How excreta expelled.

The greatest diminution of the space is effected by the simultaneous contraction of all the muscular boundaries, as in the expulsion of the excreta.

Division of space.

Division of the space. As already intimated a division of the space has been made into the ABDOMEN PROPER and the PELVIS.

Abdomen proper.

The ABDOMEN PROPER reaches from the diaphragm to the brim of the pelvis, and lodges nearly the whole of the alimentary tube and its appendages, together with the kidneys.

Pelvis.

The PELVIS is situate below the brim of the pelvis, and contains chiefly the generative and urinary organs.

Abdomen proper here described.

The following description concerns the part of the cavity between the diaphragm and the brim of the pelvis. After it has been

dissected the pelvic portion will receive a separate notice (pp. 376 *et seq*).

REGIONS OF THE ABDOMEN (fig. 108). For the surface-marking of the viscera and for the purposes of description the abdomen is

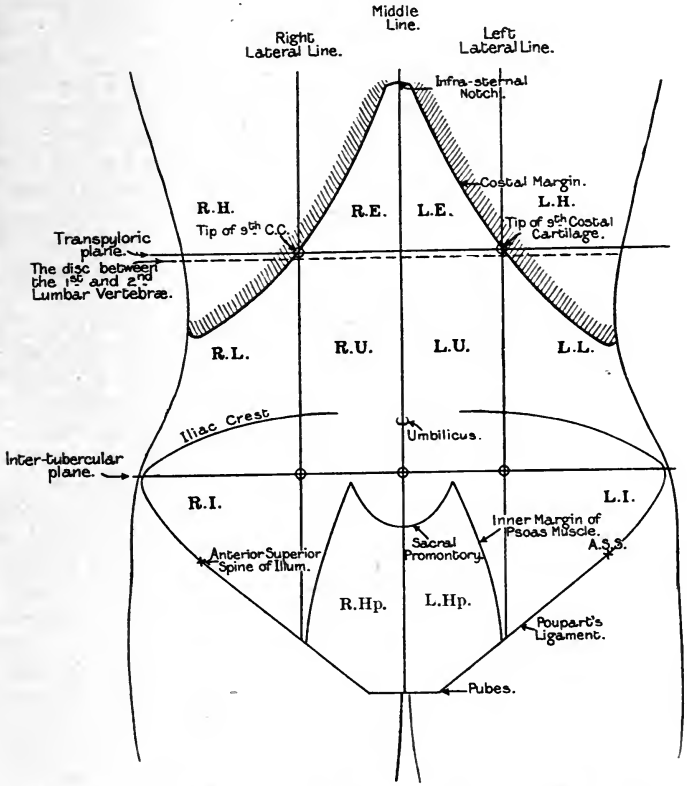


FIG. 108.—DIAGRAM SHOWING THE REGIONS OF THE ABDOMEN (C.A.).

R.E. Right epigastric region.	R.L. Right lumbar.
L.E. Left epigastric region.	L.L. Left lumbar.
R.H. Right hypochondriac.	R.Hp. Right hypogastric.
L.H. Left hypochondriac.	L.Hp. Left hypogastric.
R.U. Right umbilical.	R.I. Right iliac.
L.U. Left umbilical.	L.I. Left iliac.

divided into regions by various planes. Two of the planes are horizontal, and three vertical.

The *upper horizontal plane* is taken through a point half-way between the upper border of the symphysis pubis and the upper border of the sternum. Its level may be determined with convenience and sufficient accuracy by taking a point on the surface of the front of the body half-way between the umbilicus and the notch at

Transpyloric plane.

the lower border of the body of the sternum. This plane, from its traversing the pyloric end of the stomach, is called the *transpyloric.*

Intertubercular plane.

The *lower horizontal plane* is half-way between the transpyloric and the upper border of the symphysis pubis, and it fairly corresponds to the plane between the tubercles on the outer lips of the iliac crest (Cunningham), and is therefore called the *intertubercular.*

Vertical planes.

The *vertical planes* are represented by (1) the middle line of the body, and (2 and 3) by the right and left lateral lines. These lateral lines are drawn vertically on each side through a point midway between the middle line and the anterior superior iliac spine.

Names of regions.

The regions of the abdomen thus delimited are named respectively, from above downwards, on either side of the middle line, the right and left *epigastric, umbilical,* and *hypogastric* regions, and at the sides of the body the right and left *hypochondriac, lumbar,* and *iliac* regions.

Other subdivisions.

In addition, the middle and lower part of the hypogastric space is named pubic region, while the contiguous portions of the hypogastric and iliac constitute the inguinal region.

The various bony and other surface points already referred to on the superficial examination of the abdomen (p. 260) are useful in varying degrees as guides to the subjacent parts, but the arch formed by the costal cartilages (costal margin, fig. 108) is very variable in its position, and cannot be relied on as a surface guide except near the sternum. Moreover, the different costal cartilages often cannot be located in fat persons.

Viscera seen without displacement.

Superficial view. On first opening the abdomen the following viscera appear (fig. 109, and fig. 111, p. 303):—Above and to the right is the liver, which is in great part concealed by the ribs. Lower down, and more to the left, a piece of the stomach is visible; but this viscus lies mostly beneath the ribs and the liver. Descending from the stomach is a loose fold of peritoneum (the great omentum), which may reach to the pelvis, and conceal the small intestine, but in some bodies is raised into the left hypochondriac region, and leaves the intestine uncovered. The cæcum is usually to be seen in the right iliac region; and sometimes a part of the pelvic colon (sigmoid flexure) comes to the surface in the corresponding situation on the left side.

Close behind the pubic symphysis is the apex of the bladder (*bl*), with the urachus (*ur*) continued upwards from it; and if the organ is distended, it rises above the symphysis.

General division of alimentary tube; position of several parts;

The alimentary tube presents differences in form, and is divided into stomach, small intestine, and large intestine; and the two last are further subdivided, as will afterwards appear. The several viscera have the following general position:—The small intestine is much coiled, and occupies the greater part of the cavity; while the great intestine arches round it. Both are held in position by portions of the serous lining. Above the arch of the great intestine

and of solid organs.

are situate the stomach, the liver, and the spleen; behind is the pancreas; and below it is the convoluted small gut. Behind the intestine, on each side, is the kidney with its excretory tube.

Before the natural position of the viscera is disturbed, their situation in the different regions of the abdomen, and their relations to surrounding parts, should be examined.

Relations of viscera to be seen.

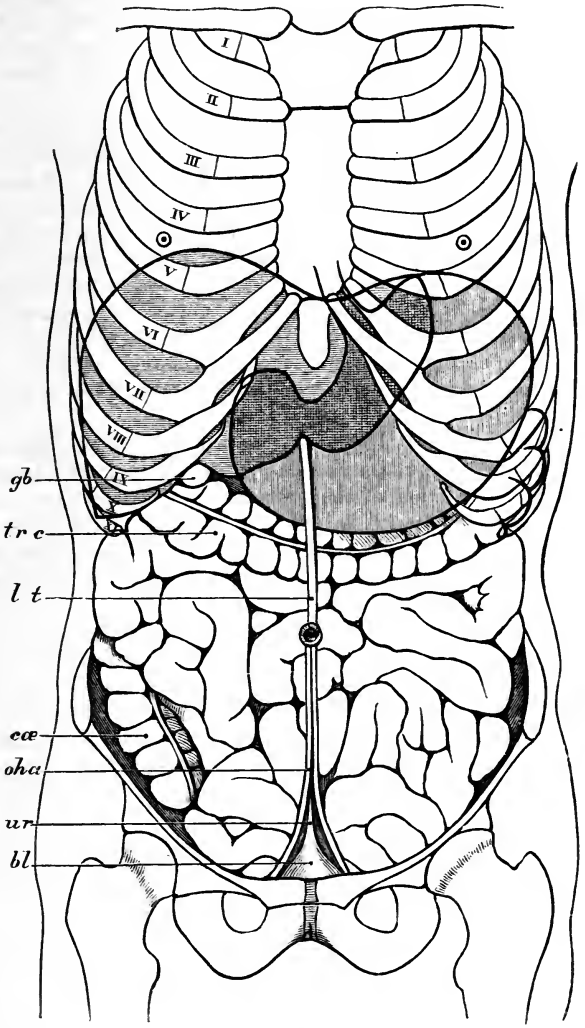


FIG. 109.—DIAGRAM SHOWING THE POSITION OF THE SUPERFICIAL ABDOMINAL VISCERA.

The LIVER is shaded with horizontal, and the STOMACH with vertical lines.

g b. Gall-bladder.
tr c. Transverse colon.
l t. Ligamentum teres of the liver.
cæ. Cæcum.
o h a. Obliterated hypogastric artery.
ur. Urachus.
bl. Urinary bladder.

RELATIONS OF THE VISCERA.

Position and relations of the stomach:

The STOMACH (figs. 110 and 111, p. 303) intervenes between the gullet and the small intestine, and is partly retained in position by folds of the serous membrane. It is somewhat pyriform in shape, with the larger end on the left side; and it is placed in the left hypochondriac and epigastric regions, and reaches to the upper part of the umbilical.

cardiac orifice,

At its large end the stomach is joined by the œsophagus, which fixes it to the diaphragm. The opening of the œsophagus into the stomach, because of its nearness to the heart (from which it is only separated by the diaphragm and pericardium), is named the *cardiac orifice*, and lies behind the seventh costal cartilage of the left side, about an inch from its junction with the sternum, being on a level with the tenth dorsal vertebra. To the left of the orifice, the stomach bulges upwards to its *summit* in the left vault of the diaphragm, and lies behind the fifth rib in the left lateral line (fig. 111). The concave border of the stomach to the right of the œsophagus is the *lesser curvature*, and is attached to the liver by a fold of peritoneum —the small omentum.

surface marking, fundus;

small curvature;

pyloric end.

The right extremity leads into the small intestine (duodenum) by the *pyloric orifice*, the situation of which is indicated externally by a slight constriction of the tube, and a thickened band in the wall that may be felt with the finger. The pyloric end of the stomach is placed beneath the liver, a little to the right of the middle line in the transpyloric plane, at the level usually of the disc between the first and second lumbar vertebræ.

Surface marking.

upper

The *upper* surface (which looks also somewhat forwards) of the stomach is in contact above and to the right with the liver, on the left with the diaphragm, and between these with the abdominal wall. The *lower* surface (compare fig. 111 and fig. 112, p. 305) lies over the spleen, to which it is connected by a fold of peritoneum (gastro-splenic omentum), the left kidney and suprarenal capsule, the pancreas, and the transverse meso-colon. This surface looks also backwards.

and lower surfaces;

great curvature is least fixed part.

The convex border or *greater curvature* is directed to the left forwards and downwards, and has the great omentum attached to it; along it lies the transverse colon.

Changes in form and position;

empty and full stomach.

The form and position of the stomach vary with its degree of distension. When the organ is empty, it is flattened, and the pyloric end reaches but little to the right of the middle line. But when full, the stomach becomes rounded, and its upper surface is directed somewhat upwards and forwards, filling particularly the left hypochondriac and epigastric regions; the fundus pushes upwards the diaphragm, pressing on the heart and left lung; the great curvature moves somewhat to the left and downwards, as well as forwards; and the pyloric extremity is carried an inch or so to the right. As will, however, be pointed out later on, the full stomach is accommodated to a great extent in a deep hollow to the left of the vertebral

column, which the late Professor Birmingham aptly called "the stomach bed."

The SMALL INTESTINE reaches from the stomach to the right iliac region, where it ends in the large intestine. It is arbitrarily divided into three parts,—duodenum, jejunum, and ileum. Small intestine: extent and divisions.

The *duodenum* comprises the first nine or ten inches of the small intestine (fig. 112, 1 to 4, p. 305). By raising the liver it may be traced from the pyloric end of the stomach, at first backwards and then downwards, until it disappears beneath the transverse colon. If the great omentum, with the attached transverse colon, be turned up over the margin of the thorax, and the mass of small intestine be drawn to the right, the lower end of the duodenum will be seen on the left of the spine. It here ascends for a short distance, and at the level of the second lumbar vertebra passes into the jejunum, forming a sharp bend forwards and downwards;—the *duodeno-jejunal flexure*. The relations of the duodenum cannot, however, be satisfactorily seen at present, and will be examined later (p. 327). Duodenum: beginning, and ending: to be fully seen later.

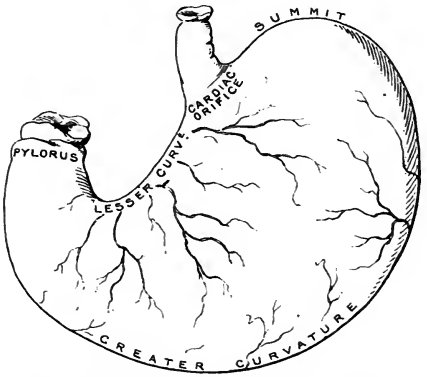


FIG. 110.—THE STOMACH OF A CHILD.

The *jejunum* and *ileum* include the remainder of the small intestine, two-fifths belonging to the jejunum and three-fifths to the ileum, but there is no natural division between them. This part of the intestinal tube forms many convolutions in the umbilical, hypogastric, left lumbar, and iliac regions of the abdomen; and it descends commonly, but more extensively in the female, into the cavity of the pelvis. In front of the convolutions is the great omentum; behind, they are fixed to the spine by a large fold of peritoneum containing the vessels and nerves, and named the mesentery. The termination of the ileum is more fixed than the rest; it ascends slightly from the pelvis to the right iliac fossa, crossing the external iliac vessels and the psoas muscle, to open into the large intestine just below the intersection of the intertubercular and right lateral lines, as marked on the surface of the body. Jejunum and ileum: situation; relations; end of ileum. Surface marking.

The LARGE INTESTINE or COLON (fig. 111) is more fixed than the jejunum and ileum, from which it is to be distinguished by its sacculated appearance, and by its being furnished with small processes of peritoneum containing fat—the *appendices epiploïcæ*. It begins in the right iliac region in a rounded part or head (cæcum), and ascends to the liver through the right iliac and lumbar regions. Then crossing the abdomen below the stomach, it reaches Large intestine: how distinguished; course

Dr. Frank D. Walsh

and extent.

the left hypochondriac region; and it lies in this transverse part of its course in the upper part of the umbilical regions. Finally, it descends, on the left side, through the regions corresponding with those it occupied on the right, and forms a remarkable bend in the pelvis on the left side; then becoming straight (rectum), it passes through the pelvis to end on the surface of the body.

Divisions.

It is divided into seven parts, viz., cæcum, ascending colon, transverse colon, descending colon, iliac colon, pelvic colon, and rectum.

Cæcum: position; relations;

The *cæcum* is placed in the right iliac fossa, above the outer half of Poupart's ligament, descending below the level of the anterior superior iliac spine in the right lateral line. When empty it may be entirely covered by the convolutions of the small intestine; but

peritoneum around it.

frequently, more or less distended, it rests against the anterior abdominal wall. The cæcum is as a rule entirely surrounded by peritoneum, which sometimes forms a small fold behind it; but occasionally it is closely bound down by the peritoneum being reflected off each side, so as to leave the hinder surface uncovered, and connected to the iliac fascia by areolar tissue.

Junction of ileum.

This part of the large intestine is joined at its inner and posterior aspect by the termination of the ileum, which marks the division between the cæcum and ascending colon. Attached to the inner part of the posterior surface of the cæcum is a slender worm-like process—the

Vermiform process.

vermiform appendix. This process is usually directed downwards and to the left under cover of the cæcum, to which it is connected by a fold of peritoneum. The root of the appendix (where it joins the

Surface marking.

cæcum) is marked on the surface of the body by a point an inch below the centre of a line drawn from the anterior superior iliac spine to the umbilicus.

Ascending colon:

The *ascending colon* reaches from the cæcum to the under-surface of the liver, where the intestine makes a bend known as the *hepatic flexure.* It lies against the iliacus and quadratus lumborum muscles, and in its upper part along the outer border of the kidney. In front and to its inner side are the convolutions of the small intestine. The

parts around.

peritoneum fixes the ascending colon to the wall of the abdomen, and surrounds commonly about two-thirds of its circumference; but it may encircle the tube and form a fold behind it (ascending meso-colon).

Transverse colon:

The *transverse colon* begins at the hepatic flexure, forming a loop downwards in the right lateral plane as far as the level of the

extent and course;

umbilicus, and then passes across to the left and upwards, along the great curvature of the stomach, as far as the spleen. Here a bend, directed mainly backwards, is formed in the lower part of the left hypochondriac region at the junction with the descending

splenic flexure;

colon, sharper than that on the right side, and named the *splenic flexure.*

In this course the transverse colon is deeper at each end than in

arch of colon;

the middle, and thus forms the *arch of the colon*, which has its convexity directed forwards. Above the arch are placed the liver

relations of arch;

and gall-bladder, the stomach, and the spleen; and below, the

convolutions of the small intestine. In passing from right to left, as will be seen by comparing figs. 111 and 112, the transverse colon first lies over the right kidney and the second part of the duodenum, and is fixed to these organs by its peritoneum, which is arranged like that of the ascending colon. Beyond the duodenum however, it is only loosely attached to the back of the abdomen by a long fold of

disposition of peritoneum.

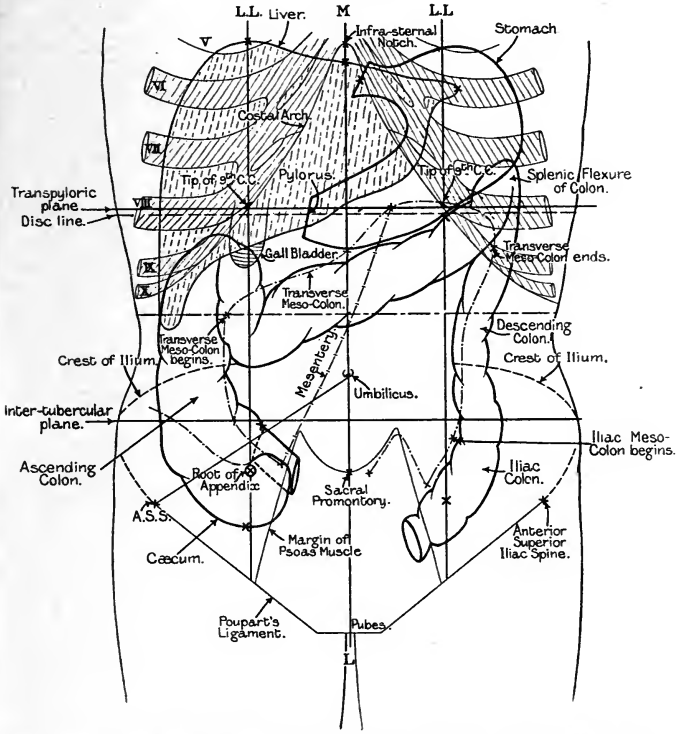


FIG. 111.—DIAGRAM SHOWING THE DISPOSITION OF THE LIVER, THE STOMACH, THE LARGE INTESTINE, AND THE LINES OF PERITONEAL ATTACHMENT, IN THE REGIONS OF THE ABDOMEN (C. A.).

M.L. Middle line. L.L. Lateral lines.
Disc line represents the disc between the first and second lumbar vertebræ.

peritoneum, the transverse meso-colon (fig. 114, *mc*, p. 309); while the great omentum (*g om*), which passes between it and the stomach, covers it in front.

The *descending colon* extends from the spleen to the iliac crest, and is longer than the ascending part. At first it is placed deeply in the left hypochondriac region, resting against the diaphragm, and partly concealed by the stomach. Lower down, it has the small intestine in front and the quadratus lumborum behind. Along the inner side, it is closely applied to the outer part of the left kidney.

Descending colon: situation;

and peritoneum. This part of the colon is smaller than either the ascending or the transverse portion, and is commonly less surrounded by the peritoneum ; its upper end is attached to the diaphragm by a special fold (phrenico-colic) of that membrane.

Iliac colon. The *iliac colon* begins at the iliac crest, and descends in the left iliac fossa, over the ilio-psoas muscle and the external iliac vessels, being fixed in this position by the peritoneum, until it reaches the brim of the pelvis. Here the intestine forms a large loop, which is provided with a long process of peritoneum, and becomes the

Pelvic colon. freely movable pelvic colon. The *pelvic colon* commonly hangs down as a loop in the cavity of the pelvis ; but it often projects forwards and reaches the anterior wall of the abdomen. Below the brim of the pelvis, opposite the third sacral vertebra, it ends in the rectum.

Rectum. The *rectum*, or the termination of the large intestine, is contained in the pelvis, and will be examined in the dissection of that cavity.

Position of liver; The LIVER (figs. 109 and 111) is situate in the right hypochondriac and lumbar and the epigastric regions, and often reaches slightly into the left hypochondriac, the left extremity being usually behind the junction of the left sixth rib with its cartilage. It is covered in front by the ribs with their cartilages, except over a small area in the subcostal angle. Folds of peritoneum, called ligaments, attach it to the abdominal parietes.

surfaces: upper, The *upper surface* fits against the diaphragm, and is convex on each side, but slightly hollowed in the centre below the heart. It extends higher up on the right side than on the left, and reaches the level of the fifth rib in the right lateral plane.

anterior, The *anterior* surface is most seen at present, and passes insensibly into the upper surface above, and terminates at the well-marked lower border below. This surface is in contact with the diaphragm under cover of the ribs and costal cartilages, and, between the costal arches, with the anterior abdominal wall. It is divided into two parts, corresponding to the right and left lobes of the organ, by the falciform ligament.

right, The superior and anterior surfaces pass insensibly into the *right* surface where the liver lies against the diaphragm on the right side and sometimes projects below the ribs at their lower part against the abdominal wall.

and inferior. The *inferior surface* looks downwards, to the left, and somewhat backwards ; it is in contact with the stomach, the first and second parts of the duodenum, the small omentum, the gall-bladder, the right kidney, and the beginning of the transverse colon. To this surface the small omentum, containing the hepatic vessels, is attached.

lower border. The *lower border* is thin and directed downwards. On the right side it is concealed by the ribs ; but in the epigastric region it is exposed, running obliquely from the ninth right to the eighth left costal cartilage : it crosses the middle line of the body a little above the transpyloric plane. The fundus of the gall-bladder projects beyond this edge, close to the costal margin in the right lateral plane.

The remaining surface of the liver, the *posterior*, cannot be seen at present. The left lobe lies in front of the œsophagus, and is attached to the diaphragm by a triangular fold of peritoneum—the left lateral ligament. The two layers of peritoneum fixing the right lobe are for the most part widely separated, and constitute the coronary ligament; but at the right end they come together, and give rise to a small triangular fold which is distinguished as the right lateral ligament

Peritoneal attachments.

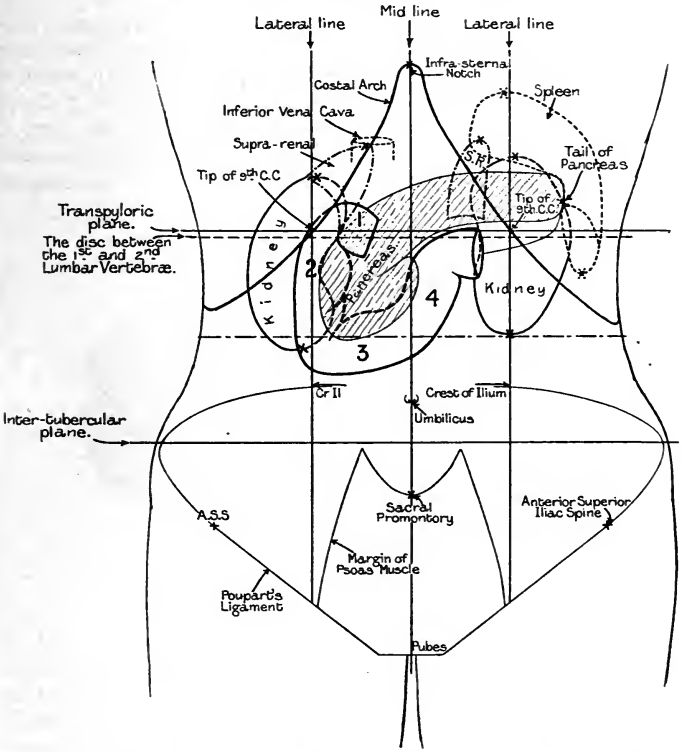


FIG. 112.—DIAGRAM SHOWING THE DISPOSITION OF THE DEEP ORGANS IN THE REGIONS OF THE ABDOMEN (C.A.).

1, 2, 3 and 4 denote the four parts of the duodenum.

The portion of the surface between the layers of the coronary ligament is adherent directly to the diaphragm by means of areolar tissue: in this space also the right suprarenal capsule touches the liver; and the inferior vena cava is embedded in a deep groove in its substance.

The liver changes its situation with the ascent and descent of the diaphragm in respiration; for in inspiration it descends, and in expiration it regains its former level, undergoing a sort of tilting downwards as it rests on the posterior body-wall. In the upright and sitting postures also, it descends lower than in the horizontal

Position is changed by diaphragm, and by postur of body.

position of the body; so that when the trunk is erect the anterior border may be felt below the edge of the ribs, but when the body is reclined, it is withdrawn within the margin of the thorax.

Spleen: position; The SPLEEN (figs. 112 and 113; also 122, p. 329) is deeply placed behind the stomach, at the back of the left hypochondrium and the adjoining part of the epigastric region. It lies very obliquely, the upper end being near the spine, while the lower end reaches about half-way round the side of the body.

relations of surfaces, phrenic, gastric, and renal. Its outer or *phrenic* surface is convex and free and rests against the diaphragm opposite the ninth, tenth, and eleventh ribs. The anterior or *gastric* surface is concave and applied to the stomach, to which it is attached by the gastro-splenic omentum (fig. 115, *gs om*, p. 310); the tail of the pancreas also touches the lower end of this surface. A third narrow surface, the internal or *renal*, lies against the outer border of the left kidney in its upper half; and a fold of peritoneum,

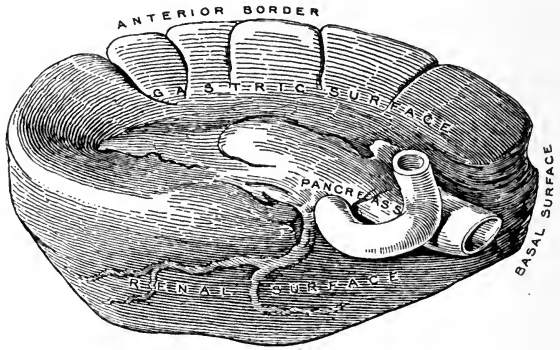


FIG. 113.—THE SPLEEN, SEEN FROM THE RIGHT.

called the lieno-renal ligament (fig. 115, *lr*), which contains the splenic vessels, passes between the two. The way to find this surface in the present stage of dissection is to pass the hand backwards within the concavity of the diaphragm on the left side, the back of the hand outwards, past the phrenic surface of the spleen, so that the fingers will hook round its posterior border and enter the recess between the spleen and the kidney. The upper end of the spleen is close to the suprarenal capsule; the lower end rests on the splenic flexure of the colon and the phrenico-colic ligament.

Examine renal surface.

Kidneys: situation; The KIDNEYS (fig. 112) cannot be seen much at present. The lower part of the left kidney will be exposed by drawing the small intestines inwards from the descending colon, and the lower part of the right kidney can be felt below the liver behind the hepatic flexure of the colon. They may be marked on the surface of the front of the body in the following manner, remembering that they are each about four inches in length and two and a half inches in width (fig. 112). The lateral planes traverse them longitudinally

surface marking.

somewhat nearer their inner than their outer borders, and the transpyloric plane crosses them transversely, a third of the right kidney being above this plane and two-thirds below, whilst two-fifths of the left kidney lie above the plane and three-fifths below.

Position: They are situated at the back of the abdomen, opposite the last dorsal and upper two or three lumbar vertebræ, and occupy parts of the epigastric, hypochondriac, umbilical, and lumbar regions. Their position is somewhat oblique, the upper end being nearer to the spine than the lower ; and the surface which is called anterior looks much outwards.

relations common to both. They lie behind the peritoneum, and are surrounded with fat. They rest upon the diaphragm, the psoas and quadratus lumborum muscles. The upper end supports the suprarenal body ; and at the inner border the vessels enter, and the duct (ureter) leaves the organ.

The differences on the two sides will be pointed out later on (pp. 353 *et seq*).

Pancreas later. The relations of the pancreas must be omitted for the present, but they will be found on pp. 329 and 330.

THE PERITONEUM.

Peritoneum: general arrangement; This is the largest serous membrane in the body. In the male it is a closed sac, like other serous membranes ; but in the female there is an aperture of communication with the Fallopian tube, and the mucous lining of the latter becomes continuous with the serous membrane. It lines the wall of the abdomen (parietal peritoneum), and is reflected over the several viscera (visceral peritoneum), some of which it invests completely, except where the vessels enter. The surfaces; inner surface is free and smooth ; but the outer is rough, when it is detached from the parts to which it is naturally adherent. The membrane as it passes from viscus to viscus, or from the abdominal wall to viscera, forms processes or folds, to which different names are folds. given, and which for the most part consist of two layers enclosing vessels.

The continuity of the sac may be traced both horizontally and vertically.

Circle of the membrane opposite umbilicus. *Horizontal circuit round the lower part of the abdomen.* From the umbilicus the peritoneum may be followed along the abdominal wall on the left side to the hinder part of the lumbar region, where it partly surrounds the descending colon, and thence over the kidney to the front of the spine. Here it is reflected forwards, covering the superior mesenteric vessels, passes round the small intestine, and returns to the spine along the same vessels, thus forming the mesentery. From the spine it is continued in the same way on the right side, over the kidney, round the colon, and along the wall of the abdomen to the umbilicus again.

Circle from above down: omental layers. *Vertical circuit* (fig. 114). Starting at the under-surface of the liver, the small omentum (*s om*) is found descending to the small curvature of the stomach, where the two layers of which it consists separate to enclose that organ, one passing in front and the other

behind. At the great curvature they meet again, and give rise to the great omentum or epiploon (*g om*). After descending to the lower part of the abdomen, they bend backwards and ascend to the transverse colon, which they enclose in the same way as the stomach; and they are then continued to the posterior abdominal wall, forming

transverse meso-colon;

the transverse meso-colon (*mc*). (It should at once be pointed out, lest the student be misled, that the layers of the great omentum in front of the transverse colon are usually adherent to one another, and not separated by intervals, as represented in fig. 114, for the purpose of clearness.) Opposite the anterior border of the pancreas these two layers, which have been followed over the transverse colon, part company,—the one passing upwards, and the other downwards.*

its ascending layer;

The ascending layer is continued upwards in front of the pancreas and diaphragm, and is then reflected on to the posterior surface of the liver, where it covers the part called the Spigelian lobe, and passes into the hinder layer of the small omentum. This layer, however, cannot be traced in the present stage of dissection.

descending layer and mesentery;

The descending layer immediately passes off along the superior mesenteric vessels to the small intestine (jejunum and ileum), forming the mesentery (*m*).

in pelvis;

From the root of the mesentery, this layer descends over the lower end of the aorta and the promontory of the sacrum to the pelvis, where it partly invests the viscera of that cavity. Thus, it covers the upper part of the rectum and is reflected forwards therefrom to the bladder in the male, or the uterus in the female, forming a pouch between the two; and after covering the upper part of the bladder, it passes off at the front and sides to the abdominal wall, forming the fossæ before noticed in the inguinal region (p. 292).

along front of abdomen.

Lastly, having left the bladder, the membrane is continued upwards, lining the anterior wall of the abdomen and the under-surface of the diaphragm, nearly as far as the spine; there it is reflected over the upper surface of the liver, and then, turning round the lower border to the under-surface, it joins the anterior layer of the small omentum.

Small and large bags:

In the foregoing account it will be seen that two vertical circles have been traced, which surround distinct cavities in figure 114. The portion of the membrane which forms the circle behind the liver and stomach is known as the *small sac* of the peritoneum; while the part in front of those organs, which is much more extensive,

* In the fœtus at an early period the reflected portion of the great omentum is continued up to the spine; and while the ascending layer passes upwards over the pancreas as explained in the text, the posterior or descending layer surrounds the transverse colon before passing into the mesentery, thus forming a transverse meso-colon distinct from the great omentum. The front of the transverse meso-colon then becomes adherent to the opposed part of the great omentum, so that the two are united in a single process, and the colon appears to be enclosed between the omental layers. Occasionally traces of the fœtal condition are met with in the adult.

and reaches into the pelvis, constitutes the *large sac*. The two sacs are however continuous, and their cavities communicate through the aperture termed the foramen of Winslow, as will be apparent by tracing the horizontal circle at a higher level than before, viz., immediately above the pyloric end of the stomach.

their continuity.

Horizontal circuit at the level of the foramen of Winslow (fig. 115, p. 310). Beginning in front at the falciform ligament of the liver (*f*), the peritoneum may be followed on the left side along the abdominal wall and the diaphragm to the outer part of the left kidney, where it is reflected along the back of the splenic vessels to the spleen, forming one layer of the lieno-renal ligament (*l r*). Having furnished the investment of the spleen, the membrane passes as the outer layer of the gastro-splenic omentum (*gs om*) to the stomach, and over the front of the latter into the anterior layer of the small omentum (*s om*). At the right edge of this it turns round the hepatic vessels (which are felt as thick cord-like structures within the peritoneal fold) to the back of the small omentum; and at the spot where it passes behind the vessels it bounds the foramen of Winslow (*w*), the entrance from the greater into the lesser sac. It then forms in succession the posterior covering of the stomach, the inner layer of the gastro-splenic omentum and lieno-renal ligament, and, turning to the right, is continued over the left kidney and the diaphragm to the inferior vena cava, where it forms the posterior boundary of the

Circle at foramen of Winslow:

covering of spleen

small omentum;

foramen of Winslow and small bag.

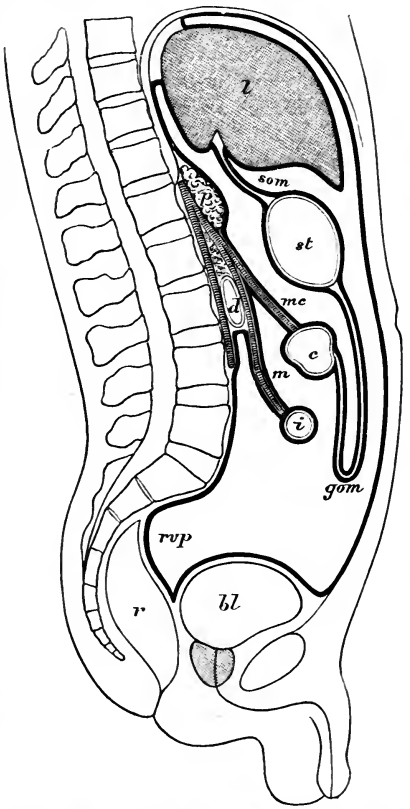


FIG. 114.—DIAGRAM SHOWING THE ARRANGEMENT OF THE PERITONEUM IN A MEDIAN SECTION OF THE ABDOMEN.

l. Liver.
st. Stomach.
c. Transverse colon.
p. Pancreas.
d. Duodenum, third part.
i, i, i. Coils of small intestine.
r. Rectum.
bl. Bladder.
s om. Small omentum.
g om. Great omentum.
mc. Transverse meso-colon.
m. Mesentery.
rv p. Recto-vesical pouch.

foramen of Winslow. Here becoming great sac again, it can be followed over the right kidney to the liver, and round the latter to the falciform ligament. On the right side of the falciform ligament the peritoneum simply passes over the liver and diaphragm.

Chief folds of the peritoneum.

Special Parts of the Peritoneum. After tracing the continuity of the serous sac over the wall and the viscera, the dissector is to study the chief processes or folds of the membrane in connection with the alimentary tube and its appendages. The pieces of peri-

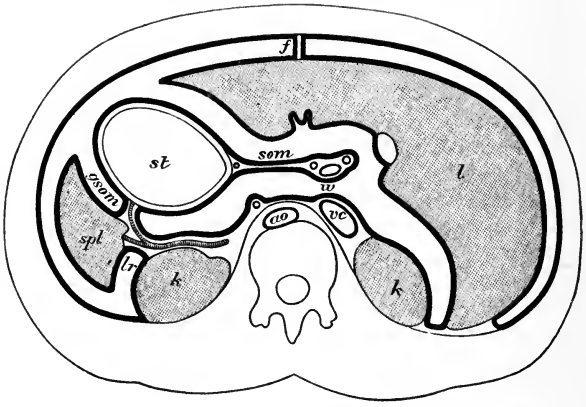


Fig. 115.—Diagram of a Horizontal Section of the Abdomen through the Twelfth Dorsal Vertebra, to show the Arrangement of the Peritoneum at the Foramen of Winslow and round the Spleen.

l. Liver.
st. Stomach.
spl. Spleen.
k, k. Kidneys.
ao. Aorta; farther forwards the coronary artery is seen, cut twice.
v c. Inferior vena cava.
w. Foramen of Winslow.
s om. Small omentum, at the right end of which are, from left to right, the hepatic artery, portal vein, and bile-duct.
gs om. Gastro-splenic omentum.
lr. Lieno-renal ligament.
f. Falciform ligament. In front of the left kidney is the splenic artery, sending its branches to the stomach between the layers of the gastro-splenic omentum.

Note.—The portions of the kidneys are represented too large in this diagram.

toneum in connection with the viscera of the pelvis will be seen in the dissection of that cavity.

Gastric folds: omenta.

Folds connected with the stomach. The processes uniting the stomach to other viscera are named *omenta*, and are three in number, viz., the small or gastro-hepatic omentum, the large or gastro-colic omentum, and the gastro-splenic omentum.

Gastro-hepatic omentum: attachments;

The *small omentum* (figs. 114 and 115, *s om*) stretches between the liver and stomach, and ends towards the right in a free border, behind which the foramen of Winslow leads into the cavity of the small sac. It is attached above to the liver along the transverse

fissure and the posterior half of the longitudinal fissure (fig. 131, *s o*, p. 346); below to the small curvature of the stomach and the first part of the duodenum. At its left or posterior end it is fixed to the diaphragm for a short distance, between the liver and the termination of the œsophagus. The part between the longitudinal fissure of the liver and the small curvature of the stomach is very thin, and can be separated into two layers only in the immediate neighbourhood of the viscera; but that extending from the transverse fissure to the duodenum is much thicker, and encloses the hepatic artery, portal vein, common bile-duct, and nerves and lymphatics of the liver. contents.

The *great omentum* (fig. 114, *g om*) is the largest fold of the peritoneum, and results from the meeting of the two layers which leave the great curvature of the stomach and the first part of the duodenum. The sheet thus formed descends in front of the intestine, extending farther on the left side than the right, and at the lower part of the abdomen is doubled backwards to join the transverse colon. The fold therefore encloses the lower part of a space (cavity of the small sac), which originally extended to its lower border; but in the adult the anterior and posterior portions of the omentum are usually closely adherent, and the small sac seldom exists below the transverse colon. Gastro-colic omentum: formation; cavity;

Between the layers of the great omentum, especially near the stomach, are some branches of vessels, minute nerves, and a variable quantity of fat; but over the greater part of their extent the layers are inseparably united, and the resulting membrane is very thin, and in places cribriform. fusion of layers.

Dissection. Divide the part of the great omentum below the stomach, and the cavity of the small sac of the omentum will be opened, and the hand may be introduced to ascertain its extent. In front it is bounded by the anterior part of the great omentum, the stomach, the small omentum, and the Spigelian lobe (fig. 131, *Sl*) of the liver. Behind it are the posterior part of the great omentum, the transverse colon and meso-colon, the pancreas, the left kidney and suprarenal capsule, and the diaphragm. To the right it extends as far as the inner border of the duodenum (second part), and to the left as far as the spleen. Between the duodenum and the liver it opens into the general cavity or large sac by the foramen of Winslow. Cavity of small bag: boundaries and extent.

The *foramen of Winslow* is bounded in front by the right portion of the small omentum, containing the hepatic vessels; below are the same vessels and the first part of the duodenum; above is the caudate lobe of the liver; and behind, the inferior vena cava. Boundaries of foramen of Winslow.

The *gastro-splenic omentum* (fig. 115, *gs om*) reaches from the stomach on the left side to the spleen, and is continued below into the great omentum. Between its layers are the gastric branches of the splenic vessels. Gastro-splenic omentum.

FOLDS ON THE LARGE INTESTINE. The disposition of the peritoneum round the several portions of the colon has been explained in giving Peritoneal folds to

large intestine: their relations (pp. 301 *et seq.*). The following processes pass between the large intestine and the abdominal wall :—

transverse meso-colon; The *transverse meso-colon* (fig. 114, *m c*) extends from the anterior or lower border of the pancreas to the transverse colon, to the left of the spot where the latter crosses the duodenum, and contains the middle colic vessels. In the adult it is formed by a continuation of the layers of the great omentum, but in the fœtus it was a separate mesentery for the bowel.

phrenico-colic fold; The upper end of the left colon has a distinct fold—*phrenico-colic* or *costo-colic*, fixing it to the wall of the abdomen. Attached by a wide end to the diaphragm opposite the tenth and eleventh ribs, it passes transversely inwards to the colon, and forms the lower boundary of a hollow in which the spleen rests.

pelvic meso-colon; The *pelvic meso-colon* is a long process of the serous membrane, which attaches the loop of the intestine to the wall of the pelvis: it contains the sigmoid and superior hæmorrhoidal vessels.

sometimes an ascending or descending meso-colon, or meso-cæcum. In some bodies the ascending and descending colon are surrounded by peritoneum, which meets behind the gut and forms a fold—the *ascending* or *descending meso-colon*, between the bowel and the abdominal wall. The cæcum may also be provided with a similar fold (*meso-cæcum*) attaching it to the right iliac fossa.

Meso-appendix. The *meso-appendix* will be seen by lifting up the cæcum, and is a fold attached on the one hand to the vermiform appendix, and on the other to the adjacent part of the cæcum and the lower surface of the mesentery near the termination of the ileum.

Appendices epiploïcæ Small processes of the peritoneum are attached along the tube of the great intestine, chiefly to the transverse and pelvic colon; they are the *appendices epiploïcæ*, and contain fat.

Peritoneal covering of small intestine. Folds to the small intestine. The small intestine is not enveloped by the peritoneum after the same manner throughout. For while the jejunum and ileum are attached to the abdominal wall by one process (mesentery), the duodenum has special relations with the serous membrane.

Peritoneum on duodenum. *Serous covering of the duodenum.* The first part of the duodenum has peritoneal relations like those of the stomach, but its posterior or left surface is only covered for a short distance by the serous membrane. The second part is concealed in front by the converging layers of the transverse meso-colon. The third part, which crosses the aorta, is separated from the peritoneum in the middle line by the superior mesenteric vessels, but is covered in front by the serous membrane on each side of them. The root of the mesentery comes off from the front of the fourth part, which is closely invested by peritoneum on the left side and partly in front.

Mesentery: form attachments. *Fold of the jejunum and ileum.* The *mesentery* supports the rest of the small intestine, and is stronger than any other piece of the serous membrane. Its hinder end is narrow, and is attached along the front of the spine and great vessels from the left side of the second lumbar vertebra to the right sacro-iliac articulation (fig. 111, p. 303; the attachment being shown by a line interrupted with short

cross lines). The other end of the fold is wide, and is connected with the intestine.

Peritoneal ligaments of the liver:

LIGAMENTS OF THE LIVER. On the upper surface of the liver is the suspensory ligament; and along the back there is a wide process which is divided into coronary, and right and left lateral ligaments.

falciform ligament;

The *suspensory* or *falciform ligament* extends from before backwards between the upper convex surface of the liver and the parietes of the abdomen. Its lower border is concave, and fixed to the liver; while the upper border is convex, and is connected to the abdominal wall on the right of the linea alba, and to the under-surface of the diaphragm. In its free anterior border or base is the remains of the umbilical vein, which is named the *round ligament of the liver.*

coronary ligament;

The *coronary ligament* is placed at the back of the right lobe of the liver, and is composed of two layers which are separated by an interval (fig. 114). The superior layer passes from the liver to the diaphragm; but the inferior layer (fig. 131, *i c l*, p. 346) is reflected over the front of the kidney and inferior vena cava. This layer becomes continuous round the Spigelian lobe with the posterior layer of the small omentum.

right lateral ligament;

The *right lateral ligament* (fig. 131, *r l l*) is a small fold at the right end of the coronary ligament, formed by the meeting of the two layers for a short distance.

left lateral ligament;

The *left lateral ligament*, larger than the foregoing, is a triangular fold of peritoneum, with a free edge turned to the left. It is attached by its anterior border to the liver above the margin of the left lobe, and by its posterior border to the diaphragm in front of the œsophageal opening. At its right end the upper layer is continued into the left side of the falciform ligament, and the lower layer into the front of the small omentum.

Splenic folds.

FOLDS OF THE SPLEEN (fig. 115). These are the gastro-splenic omentum and the lieno-renal ligament, the formation of which has already been explained.

ACCESSORY PERITONEAL FOLDS AND FOSSÆ. Minor peritoneal folds and fossæ should be looked for in the neighbourhood of the duodeno-jejunal flexure and about the cæcum; also the lower surface of the pelvic meso-colon should be examined for the mouth of a small pouch (*intersigmoid*) that sometimes exists there. Two pouches are often found in the neighbourhood of the duodeno-jejunal flexure. One, to the left of the upper part of the flexure, looking downwards, is called the *superior duodenal fossa*, and another, along the left side of the last (fourth) part of the duodenum looking upwards, is called the *inferior duodenal fossa.* A *para-duodenal* fossa is occasionally found to the left of the last part of the duodenum on the posterior abdominal wall, being produced by a fold raised by the inferior mesenteric vein.

Duodenal fossæ.

Superior,

inferior,

para.

Retro-colic fold.

Running up behind the cæcum or the beginning of the ascending colon there is often a *retro-colic* fold, producing a pouch on one or both sides of it, more commonly on the inner side. A very constant

Ileo-cæcal fold and pouch.

fold (*ileo-cæcal*), mostly containing fat, passes from the lower border of the last three inches or so of the ileum on to the cæcum and appendix, often producing a deep pouch looking downwards and to the left.

Ileo-colic fold and pouch.

A small *ileo-colic* fold, produced by a branch of the ileo-colic artery, is sometimes seen immediately above the ileo-colic junction, producing a pouch looking upwards.

MESENTERIC VESSELS AND SYMPATHETIC NERVES.

Examine first vessels to intestine.

Directions. The mesenteric vessels and nerves, which supply the greater part of the alimentary tube, may be first dissected. After these have been examined and the relations of the aorta and vena cava have been learnt, most of the intestine will be taken out for examination and to give room for the display of the viscera and vessels in the upper part of the abdomen.

Mesenteric vessels.

MESENTERIC VESSELS. The superior and inferior mesenteric arteries are two large branches of the aorta, which supply the intestine, except a part of the duodenum and some of the rectum. Each is accompanied by a vein, and by a plexus of the sympathetic nerve.

Dissection of superior mesenteric vessels,

Dissection (fig. 116). For the dissection of the superior mesenteric vessels and nerves, the transverse colon and the great omentum are to be lifted up and placed over the margin of the ribs. The small intestines should be drawn over to the left, and spread out fanwise, so that the anterior or right layer of the mesentery can be removed. While tracing the branches of the artery to the small intestine, corresponding veins and slender offsets of the sympathetic nerve on the arteries will be met with. Mesenteric glands and lacteal vessels also come into view at the same time.

The branches from the right side of the vessel to the large intestine are to be next followed under the peritoneum ; and after all the branches have been cleaned, the trunk of the artery should be traced back beneath the pancreas. The surrounding plexus of nerves should also be defined.

and nerves.

Superior mesenteric artery

The SUPERIOR MESENTERIC ARTERY (fig. 116, *a*) supplies all the small intestine beyond the duodenum and half the large intestine, viz., as far as the end of the transverse colon.

courses in the mesentery ;

Arising from the aorta near the diaphragm, it is directed downwards between the layers of the mesentery, forming an arch with the convexity to the left side, and terminates in offsets to the

relations,

end of the small intestine. At first the artery lies beneath the pancreas and the splenic vein ; and as it descends to the mesentery it is placed in front of the left renal vein and the duodenum. It is surrounded by a plexus of nerves, and accompanied by the vein of the same name.

and branches

BRANCHES. The artery furnishes a small offset to the pancreas and duodenum, intestinal branches to the jejunum and ileum, and colic branches to the large intestine.

a. The *inferior pancreatico-duodenal artery* (*b*) is small, and usually arises in common with the first intestinal branch. It is directed to the right between the pancreas and duodenum, to both of which it supplies branches, and anastomoses with the superior pancreatico-duodenal artery from the hepatic. Pancreatico-duodenal.

b. The *intestinal branches* for the jejunum and ileum (*f*) are twelve or more in number, and pass from the left side of the artery between Branches to small intestine:

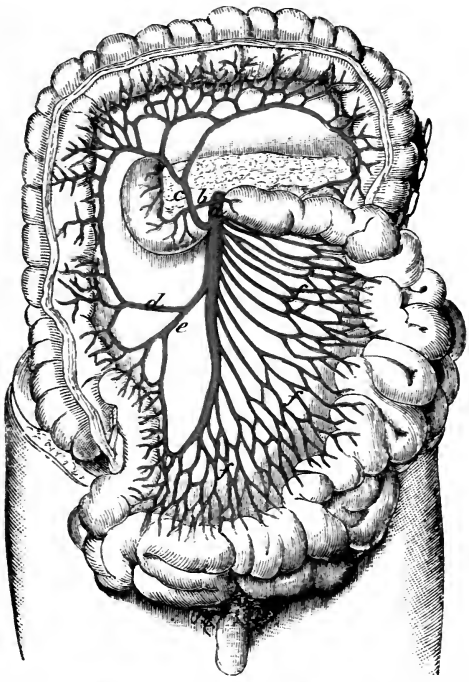


FIG. 116.—SUPERIOR MESENTERIC ARTERY AND ITS BRANCHES (TIEDEMANN).

a. Superior mesenteric.
b. Inferior pancreatico-duodenal.
c. Middle colic.
d. Right colic.
e. Ileo-colic.
f. Intestinal branches to the jejunum and ileum.

the layers of the mesentery. About two inches from their origin the branches bifurcate, and the resulting pieces unite with similar offsets from the collateral arteries, so as to form a series of arches. From the convexity of the arches other branches take origin, which divide and unite as before. This process is repeated three or four times between the origin and the distribution, but at each branching the size of the vessels diminishes. From the last set of arches twigs are sent to the intestine on both aspects of the tube, and anastomose round it. branches form arches; distribution on the gut.

Arteries of large gut.

The *branches to the large intestine* are three in number, ileo-colic, right colic, and middle colic arteries.

Ileo-colic branch runs to cæcum.

c. The *ileo-colic artery* (*e*) arises from the right side of the trunk, and divides opposite the cæcum into ascending and descending branches. The ascending branch supplies the cæcum and the beginning of the ascending colon, and anastomoses with the right colic artery ; while the descending branch joins in a loop with the termination of the mesenteric trunk, and distributes offsets to the lower end of the ileum. The ascending branch sends an artery (*appendicular*) behind the termination of the ileum, which enters the meso-appendix, and is distributed to the appendix.

Right colic branch supplies ascending colon.

d. The *right colic artery* (*d*) is frequently conjoined at its origin with the preceding. Near the ascending colon it divides into ascending and descending branches, which anastomose with the ileo-colic artery on the one side, and with the middle colic on the other.

Middle colic branch passes to transverse colon ;

e. The *middle colic branch* (*c*) springs from the upper part of the artery, and entering between the layers of the transverse meso-colon, divides into two branches ; the right one anastomoses with the artery to the ascending colon, and the left with the left colic branch

number and arrangement in arches.

of the inferior mesenteric artery (fig. 117, *c*). The intestinal twigs are united in arches before entering the gut, like those to the small intestine.

Superior mesenteric vein.

The *superior mesenteric vein* (fig. 125, *b*, p. 334) is formed by the union of branches from the intestine corresponding to the offsets of the artery. The trunk passes beneath the pancreas on the right side of the artery, and there joins the splenic vein to form the vena portæ. At the lower border of the pancreas it receives the right gastro-epiploïc branch from the stomach.

Mesenteric glands ;

The MESENTERIC LYMPHATIC GLANDS are numerous between the layers of the mesentery. An upper group lies by the side of the artery, and contains the largest glands ; and a lower group, near the

lymphatics entering them.

intestine, is lodged in the intervascular spaces. The chyliferous vessels of the small intestine, and the absorbents of the part of the large intestine supplied by the superior mesenteric artery, pass through the mesenteric glands in their course to the thoracic duct.

Meso-colic glands.

Along the side of the ascending and the transverse colon are a few other small lymphatic glands, *meso-colic*, which receive some absorbents of the large intestine.

Dissection of inferior mesenteric artery,

Dissection (fig. 117). By drawing the small intestine over to the right side, the dissector will observe the inferior mesenteric artery on the front of the aorta, a little above the bifurcation. The peritoneum should be removed from its surface, and the branches should be traced outwards to the remaining half of the large intestine ; a part of the artery enters the pelvis, but this will be dissected afterwards. On the artery and its branches the inferior mesenteric plexus of nerves ramifies, and should be preserved, especially near the origin of the vessel.

and vein :

The inferior mesenteric vein also is to be followed upwards

beneath the pancreas to its junction with the superior mesenteric or the splenic vein.

On the aorta the dissector will meet with a plexus of nerves, which is to be left uninjured. aortic plexus.

The INFERIOR MESENTERIC ARTERY (fig. 117, *b*) supplies branches to the large intestine beyond the transverse colon, and communi- Inferior mesenteric artery:

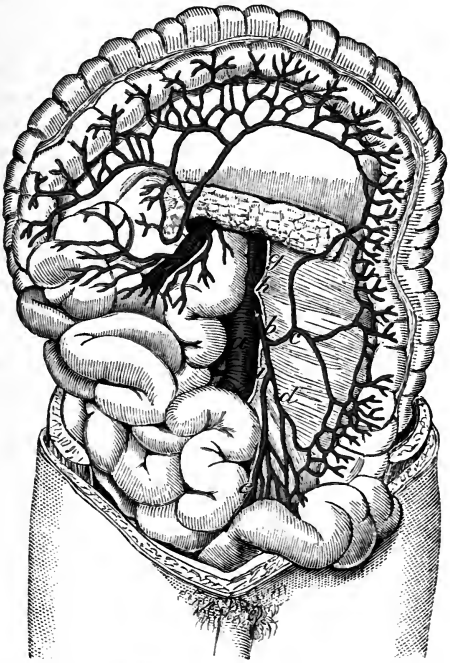


FIG. 117.—THE INFERIOR MESENTERIC ARTERY, AND THE AORTA, AS SEEN BY TURNING ASIDE THE UPPER MESENTERIC ARTERY AND THE SMALL INTESTINE (TIEDEMANN).

a. Aorta.
b. Inferior mesenteric artery.
c. Left colic, *d*. Sigmoid, and *e*. Superior hæmorrhoidal branches.
f. Superior mesenteric.
g. Renal.
h. Spermatic of the left side.

cating with the superior mesenteric, continues the chain of anastomoses along the intestinal tube.

This vessel is of smaller size than the superior mesenteric, and arises from the aorta from one to two inches above the bifurcation. It descends, lying at first on, and then close to the left side of the aorta, and, after giving off branches to the descending, iliac and pelvic colon, terminates as the superior hæmorrhoidal artery to the rectum. origin, and branches.

a. The *left colic artery* (*c*) passes out in front of the left kidney, and divides into an ascending and a descending branch for the Left colic branch to descending colon.

supply of the descending colon: by the ascending offset it anastomoses with the middle colic branch of the superior mesenteric.

Sigmoid branch to sigmoid flexure.

b. The *sigmoid artery* (or commonly *arteries*) (*d*) is distributed to the iliac and pelvic colon (sigmoid flexure), and divides into offsets which anastomose above with the preceding colic, and below with the hæmorrhoidal branch. Here, as in the rest of the intestinal tube, arches are formed by the arteries before they reach the intestine.

Branch to rectum.

c. The *superior hæmorrhoidal artery* (*e*) crosses over the left common iliac vessels, and enters between the layers of the pelvic meso-colon, to be distributed to the lower end of the large intestine, its branches reaching in the mucous membrane of the rectum as far as the anus: it will be described in the dissection of the pelvis.

Inferior mesenteric vein: origin, course, and termination.

The *inferior mesenteric vein* (fig. 125, *d*, p. 334) begins in the part of the large intestine to which its companion artery is distributed, and ascends over the psoas muscle higher than the origin of the artery. Passing beneath the pancreas, the vein inclines to the right, and opens into the superior mesenteric trunk at its junction with the splenic, or sometimes into the splenic vein.

No valves in veins.

Both mesenteric veins are without valves, and may be injected from the trunk to the branches, like an artery.

Lymphatic glands.

Lymphatic glands are ranged along the descending colon and the sigmoid flexure. The absorbents of the intestine, after passing through these glands, enter the left lumbar lymphatic glands.

Plexuses of the sympathetic to the viscera.

Sympathetic Nerve. The following plexuses of the sympathetic on the vessels, viz., superior mesenteric, aortic, spermatic, and inferior mesenteric, are derived from the solar plexus beneath the stomach, and can now be exposed. The remaining portion of the sympathetic nerve in the abdomen will be subsequently referred to (pp. 336 *et seq.*).

Dissection of aortic plexus, and hypogastric plexus.

Dissection. On the two mesenteric arteries the dissector will have already made out the plexuses of nerves distributed to the intestinal tube beyond the duodenum.

He has now to trace on the aorta the connecting nerves between the mesenteric plexuses, by taking away the peritoneum from the front of the aorta below the pancreas. From the upper part of the aortic plexus an offset is to be followed along the spermatic artery; this may be done on the left side, where that vessel is partly laid bare.

By detaching the peritoneum below the bifurcation of the aorta, and following downwards over the iliac arteries the nerves from the aortic plexus and the lumbar ganglia, the dissector will arrive at the hypogastric plexus, above the promontory of the sacrum.

Superior mesenteric plexus is on artery of same name: secondary plexuses.

The *superior mesenteric plexus* is a large bundle of nerves, and is distributed to the same extent of the intestinal tube as the mesenteric artery. The nerves surround closely the trunk and larger branches of the artery; but near the intestine some of them leave the vessels, and divide and communicate before entering the gut. The offsets of the main plexus are named after the arteries which they accompany, viz., intestinal nerves to the small intestine, and ileo-colic, right colic, and middle colic plexuses to the large intestine.

The *aortic plexus* is an open network of nerves covering the aorta below the superior mesenteric artery; it is stronger on the sides than on the front of the aorta, in consequence of its receiving accessory branches from the lumbar ganglia, especially the left. Above, the plexus derives an offset, on each side of the aorta, from the solar and renal plexuses. It ends below, on each side, in branches which cross the common iliac artery, and enter the hypogastric plexus. From it offsets are furnished to the spermatic and inferior mesenteric arteries. Aortic plexus, offsets.

The *spermatic plexus*, formed by roots from both the aortic and the renal plexus, runs on the spermatic artery to the testicle; in the cord it joins other filaments on the vas deferens. Spermatic plexus:

In the female, the nerves on the ovarian (spermatic) artery are furnished to the ovary and the uterus. in female.

The *inferior mesenteric plexus* supplies the part of the intestinal tube to which its artery is distributed. This plexus is furnished from the left side of the aortic plexus; and the nerves composing it are whiter and larger than in either of the preceding plexuses of the sympathetic. Near the colon the branching of the nerves and the union of contiguous twigs are well marked. Its offsets (plexuses) are left colic, sigmoid, and superior hæmorrhoidal: they ramify on those arteries, and have a like distribution. Inferior mesenteric plexus: nerves join like the vessels; secondary plexuses.

The *hypogastric plexus*, or the large prevertebral centre for the upply of sympathetic nerves to the viscera of the pelvis, is situate in front of the last lumbar vertebra. It is formed by the union of the prolongations of the aortic plexus; and the nerves composing it are of large size, and interlace in a dense flattened mass, without any interspersed ganglia. Below, the plexus divides into two portions, right and left, which are continued downwards on the inner side of internal iliac vessels to the pelvic plexuses. Hypogastric plexus: situation; formation; and ending.

RELATIONS OF AORTA AND VENA CAVA.

Before any of the viscera are removed from the body, the relations of the abdominal aorta and vena cava may be learnt.

Dissection. To see the aorta above the origin of the superior mesenteric artery, it will be necessary to detach the great omentum from the stomach, without injuring the gastro-epiploïc arteries along the great curvature; and after raising the stomach, to remove the peritoneum from the gastric surface of the pancreas. A short arterial trunk (cœliac axis) above the pancreas is not to be quite cleaned now, otherwise the nerves about it would be destroyed. Dissection of aorta,

The vena cava on the right side of the aorta may be followed up as far as the liver, where it disappears, by separating the transverse colon from the duodenum and by carefully lifting up the outer part of the duodenum; where the latter lies over the inner part of the right kidney, the confluence of the renal vein and the inferior vena cava will be exposed. Care must be taken however not to injure the duodenum and the adjacent head of the pancreas. The relations of and vena cava.

its upper end of the vein can be better observed after the dissection of the vessels of the liver.

Aorta lies on front of spine:

The AORTA (fig. 138, p. 363) enters the abdomen between the pillars of the diaphragm, and finally divides into the common iliac arteries opposite the fourth lumbar vertebra. At its beginning the vessel lies somewhat to the left of the middle line; and it commonly inclines slightly inwards as it descends.

parts around.

In the abdomen the aorta is covered at first by the pancreas, then by the third part of the duodenum, and for a short distance below that by the peritoneum. Beneath the pancreas it is crossed by the splenic vein above the superior mesenteric artery, and by the left renal vein below that vessel; and the solar and aortic plexuses of the sympathetic lie along its anterior surface throughout. It rests on the lumbar vertebræ, with the pillars of the diaphragm embracing it at the beginning. To its right side is the vena cava. Its relation to other deep parts cannot be examined at present.

Vena cava inferior: extent;

The INFERIOR VENA CAVA begins opposite the fifth lumbar vertebræ by the union of the common iliac veins, and reaches thence to the heart.

relations; is by the side of the aorta,

The venous trunk is placed on the front of the vertebral column, to the right of the aorta (fig. 138). It lies close to the aorta, and is concealed by the duodenum and pancreas as high as the crus of the diaphragm; but above that spot it is inclined away from the artery, and ascending in front of the diaphragm, is embedded in the back of the liver for about an inch and a half. Lastly, it leaves the abdomen by an aperture in the tendinous centre of the diaphragm, on the right of, and higher than the aortic opening.

except above.

Arteries crossing it,

Its relations with vessels are not the same as those of the aorta. Beneath it are the right lumbar, renal, capsular, and diaphragmatic arteries; and crossing over it below the kidney is the right spermatic artery. Superficial to it beneath the pancreas is the beginning of the portal vein.

and vein.

REMOVAL OF THE INTESTINES.

Dissection. The jejunum, the ileum, and the whole of the large intestine, as far as the lower part of the pelvic colon, are now to be removed. Place two ligatures on the jejunum, one at the duodeno-jejunal flexure and another an inch further on, and divide the bowel between them. In the same way divide the lower part of the pelvic colon between a double ligature. The whole of the intestine between these points is then removed by cutting through its peritoneal attachment close to the bowel wall. Care should be taken not to cut into the bowel, and in removing the transverse colon the arteries of the stomach must be avoided.

After removal, ligature the ileum about six inches from the ileo-colic junction and divide it above the ligature. Proceed then in the following manner:—

1. Cut off the upper four inches of the jejunum and the lower four inches of the ileum above the cut, and put them aside in a tray in water.

2. Cut off the next twelve inches of the jejunum ; wash it through with running water from the tap, inflate it with air, and hang it up to dry.

3. Cut through the ascending colon about six inches above the ileo-colic junction. Wash through the detached portion, consisting of the lower part of the ileum, the cæcum, and a piece of the ascending colon, inflate it, and hang it up to dry.

4. Remove the pieces of mesentery left on the remaining long piece of the small intestine. Wash the intestine through from end to end by putting one end on the tap and allowing the water to run through freely ; and, finally, treat the remainder of the large intestine in the same way.

SMALL INTESTINE.

The JEJUNUM and the ILEUM together measure about twenty feet in length, and are connected with the mesentery. There is not any perceptible difference between the termination of the one and the beginning of the other, but two-fifths of the length are assigned to the jejunum, and three-fifths to the ileum. Between the upper and lower extremities, however, a marked difference may be perceived. The upper part of the jejunum is thicker and more vascular than the lower end of the ileum ; it is spongy to the feel, owing to its voluminous mucous membrane, and markedly differs from the thin-walled ileum ; the width of the upper part of the jejunum is also greater. Jejunum and ileum. Characters.

STRUCTURE. In the small intestine the wall is formed by the same number of layers as in the stomach, viz., serous, muscular, fibrous, and mucous. Structure

Dissection. Open the small pieces of jejunum and ileum by cutting along the mesenteric attachment ; pin them out on cork with the mucous membrane uppermost. Wash them gently with water, and remove all contained matter and adhering mucus, and examine the villi with a hand lens.

Villi. The mucous membrane will be seen to be thickly studded with small projections, like those on velvet. These bodies exist along the whole of the small intestine, and are irregular in form (fig. 118), some being triangular, others conical or cylindrical with a large end. Their length is from $\frac{1}{40}$th to $\frac{1}{20}$th of an inch ; and they are best marked where the valvulæ conniventes are largest. In the duodenum their number is estimated at 50 to 90 in a square line, but in the lower end of the ileum at only 40 to 70 on the same surface (Krause). The villi. Their shape, size, and number.

Dissection. Now turn the pieces of intestine and pin them out on the cork with the serous coat outermost.

The serous covering is to be torn off for a short distance, to show the muscular coat, but in doing this the external longitudinal fibres will be taken away unless great care is observed.

The *serous coat* is closely connected with the subjacent muscular layer. To the jejunum and ileum it furnishes a covering, except Serous coat

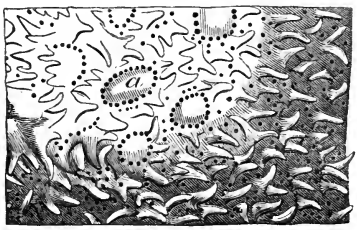
nearly complete. at the attached side where the vessels enter: at this spot the peritoneum is reflected off to form the mesentery, and a space exists between the serous layers like that at the borders of the stomach.

Muscular coat is formed by a The *muscular coat* is constructed of two sets of fibres, a superficial, longitudinal, and a deep, circular. The fibres are pale in colour, and are not striated.

longitudinal The *longitudinal fibres* form a thin covering, which is most marked at the free border of the gut.

and a circular layer. The *circular fibres* are much more distinct than the others, and give the chief strength to the muscular coat. These circular fibres are best exposed by again turning the specimen and stripping off the mucous membrane and the subjacent submucous tissue in one piece.

Show mucous coat. **Dissection.** The long length of small intestine should now be opened to show the mucous coat, but the gut should be cut along the line of attachment of the mesentery, so as to avoid Peyer's glands on the opposite side.



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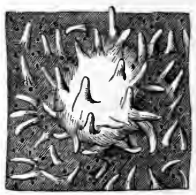


B

FIG. 118.—A. A PIECE OF MUCOUS MEMBRANE ENLARGED, WITH ITS VILLI AND TUBULES. PART OF A PEYER'S PATCH IS ALSO REPRESENTED WITH THE FOLLICLES (*a*), EACH HAVING A RING OF TUBES AT THE CIRCUMFERENCE.

B. A "SOLITARY GLAND" OF THE SMALL INTESTINE, ALSO ENLARGED, COVERED BY VILLI (BOEHM).

Mucous coat: thickness; folds; villous surface, and glands. *Mucous coat.* The lining membrane is thicker and more vascular at the beginning than at the ending of the small intestine. It is marked by numerous prominent folds (valvulæ conniventes); and the surface of the membrane is covered with small processes (villi) like the pile of velvet. Occupying the substance of the mucous coat are numerous glands.

Valvulæ conniventes; form; size and depth; how formed; The *valvulæ conniventes* are permanent ridges of the mucous membrane, which are arranged circularly in the intestine and project into the cavity of the tube. Crescentic in form, they extend round the intestine for half or two-thirds of its circumference, and some end in bifurcated extremities. Larger and smaller folds are met with, sometimes alternating; and the larger are about two inches long, and one-third of an inch in depth towards the centre. Each is formed of a doubling of the mucous membrane, which encloses a prolongation of the submucous coat, with vessels between the layers.

They begin, as will be seen, in the duodenum, about one or two inches beyond the pylorus, and are continued in regular succession to the middle of the jejunum ; but beyond that point they become smaller and more distant from one another, and finally disappear about the middle of the ileum, having previously become irregular and rudimentary. The folds are largest and most uniform beyond, and not far from the opening of the bile-duct. By inspection of the dried portion of the jejunum the disposition of these folds is readily seen. extent on the intestine.

GLANDS. In the glandular apparatus of the small intestine are included the crypts of Lieberkühn, solitary glands, and Peyer's and Brunner's glands, the last-named occurring only in the duodenum.

The *crypts of Lieberkühn* are minute simple tubes, which exist throughout the small intestine. They open on the surface of the mucous membrane by small orifices between the villi, and around the larger glands ; but they are not to be recognised with the naked eye. Simple tubes.

The so-called *solitary glands* (fig. 118, B) are roundish white eminences, about the size of mustard-seed if distended, which are scattered along the small intestine, but in greatest number in the ileum. Placed on all parts of the intestine, and even on or between the valvulæ conniventes, they are covered by the villi of the mucous membrane, and are surrounded at their circumference by apertures of the crypts of Lieberkühn. These small bodies are nodules of lymphoid tissue. Solitary follicles ; size and situation ;

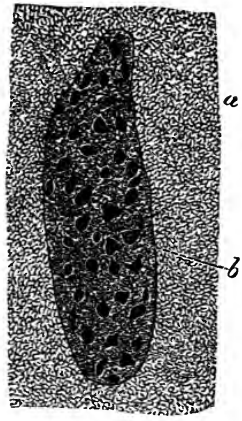


FIG. 119.—PEYER'S PATCH, FOUR TIMES ENLARGED (KÖLLIKER).

a. Surface of mucous membrane covered with villi.
b. Pits over the follicles where villi are absent. composition.

The *agminated glands* or *glands of Peyer* (fig. 119) exist chiefly in the ileum, and, beginning at the lower end, they should be looked for by holding the bowel up against the light. They form oval patches, measuring from half an inch to two inches or more in length, and about half an inch in width. They are situate on the part of the intestine opposite to the attachment of the mesentery, and their direction is longitudinal in the gut : usually they are from twenty to thirty in number. In the lower part of the ileum they are largest and most numerous ; but they decrease in number and size upwards from that spot, till at the lower end of the jejunum they become irregular in form, and may consist only of small roundish masses. The patches are most distinct in young persons, and generally disappear in old age. Patches of Peyer : size ; situation ; number ; peculiarities ;

The mucous membrane over the glands is hollowed into pits (fig. 119, *b*), and is generally destitute of villi (fig. 118, A) ; but between the pits it has the same characters as in other parts.

composition. These patches are simply collections of lymphoid nodules of the same nature as the "solitary glands."

Arteries of the intestine; *Vessels of the intestine.* The *arteries* are derived from the intestinal branches of the superior mesenteric trunk, and enter the wall of the intestine at the attached border. They run at first beneath the serous coat, round the side of the bowel, and give off numerous ramifications, which anastomose freely together, and perforate the muscular coat, supplying branches to its substance. Finally, they break up into very minute twigs in the submucous layer, before

veins; entering the mucous coat. The *veins* have their usual resemblance to the companion arteries.

absorbents; The *absorbents* (lacteals) leave the intestine with the vessels and pass to the mesenteric glands.

and nerves. *Nerves* of the small intestine come from the upper mesenteric plexus, and entering the coats by the side of the arteries, form plexuses with interspersed ganglia.

LARGE INTESTINE.

Extent of the gut; The large intestine is the part of the alimentary canal between the termination of the ileum and the anus.

length; In length it measures about five or six feet,—one-fifth of the length

size. of the intestinal tube. The diameter of the colon is largest at the commencement of the cæcum, and gradually decreases as far as the upper part of the rectum: in the lower part of the rectum there is a dilatation above the anal canal.

Compared with small gut, larger, When compared with the small intestine, the colon is distinguished by the following characters:—It is generally of greater capacity,

more fixed, being in some places as large again, and is more fixed in its position.

not coiled, Instead of being a smooth cylindrical tube, the colon is sacculated,

sacculated with bands. and is marked by three longitudinal muscular bands, which alternate with as many rows of dilatations. Its wall is thicker and attached to

Appendages. the surface, especially along the transverse and pelvic colon, are small processes of peritoneum containing fat—the appendices epiploïcæ.

The inflated portion of the large intestine, containing the ileo-colic junction, will now be examined.

Definition of cæcum; The CÆCUM, or the head of the colon (fig. 120, *a*), is the rounded end of the large intestine, which projects, in the form of a pouch,

length and width; below the entrance of the ileum. It measures about two inches and a half in length, and rather more in width, though gradually narrowing below: it is the widest part of the colon. At its inner

receives ileum and appendix. side it is joined by the small intestine (*b*); and still lower there is a small worm-like projection (*c*)—the vermiform appendix.

Vermiform appendix: *Appendix vermiformis* (fig. 120, *c*). This little convoluted tube is

attachment; attached to the lower and hinder part of the cæcum, of which it was a continuation at one period in the embryo. From three to six

dimensions; inches in length, the appendix is rather larger than a goose-quill, and is connected to the inner side of the cæcum and to the lower face

it is hollow. of the mesentery of the ileum by the meso-appendix. Its interior

has an aperture of communication with the intestine (*d*). In structure it resembles the rest of the colon, except that the longitudinal muscular bands coalesce upon it. Its mucous membrane contains a great amount of adenoid tissue.

Dissection. To examine the interior of the dried specimen of the cæcum, and the valve between it and the small intestine, the following cuts should be made in it:—One oval piece is to be taken from the upper aspect of the ileum near its termination; and another from the side of the cæcum, opposite the entrance of the small intestine.

Ileo-colic valve (fig. 120). This valve is situate at the entrance of the ileum into the large bowel. It is composed of two pieces, which project into the interior of the colon and bound a narrow, nearly transverse, aperture of communication between the two parts of the intestinal canal.

The upper piece of the valve, *ileo-colic* (*e*), projects horizontally into the large intestine, opposite the junction of the ileum with the colon. And the lower piece, *ileo-cæcal* (*f*), which is the larger of the two, has a nearly vertical direction between the ileum and the cæcum. At each extremity of the opening the pieces of the valve are blended together; and the resulting prominence (*g*) extends transversely on the front and back of the intestine, forming the *fræna* or *retinacula* of the valve.

The size of the opening is altered by the distension of the intestine; for when the retinacula of the valve are stretched the folds bounding the aperture are approximated, and may be made to touch.

Each piece of the valve is formed by circular muscular fibres of the intestinal tube, covered by mucous membrane and submucous tissue; and the ileum projects into the interior of the cæcum as if it were thrust obliquely through the wall of the cæcum, after being deprived of its peritoneal coat and the layer of longitudinal fibres. This construction is easily seen on a fresh specimen by dividing the peritoneum and the longitudinal fibres, and gently drawing out the ileum from the cæcum.

Situation of the valve;

two pieces in it.

One ileo-colic;

the other ileo-cæcal;

these are joined at the ends,

and form fræna.

Opening in the valve.

The valve a prolongation of the wall of the gut.

FIG. 120.—INTERIOR OF THE CÆCUM, DRIED AND LAID OPEN.

a. Cæcum.
b. Small intestine.
c. Vermiform appendix, and *d*, its aperture.
e. Ileo-colic piece of the valve at the junction of the small intestine.
f. Ileo-cæcal piece of the valve.
g. Retinaculum of the valve on each side.

Appendix opens into cæcum.

The *opening of the appendix* into the cæcum (*d*) is placed below that of the ileum. The mucous membrane partly closes the aperture and acts as a valve.

Ridges in the cæcum; how formed.

Folds or *ridges* are directed transversely in the interior of the gut, and correspond with depressions on the outer surface: these folds result from the doubling of the wall of the intestine, and the largest enclose vessels.

Dissection. Portions of the transverse colon and the pelvic colon should be examined to show the disposition of their coats, in the same way as the pieces of small intestine, after the whole piece of large intestine has been slit open and washed clean.

Four strata in the wall of the gut.

STRUCTURE OF THE COLON. The coats of the large are similar to those of the small intestine, viz., serous, muscular, fibrous, and mucous.

Serous coat differs along the intestine.

Serous coat. The peritoneum does not clothe the large intestine, throughout, in the same degree. It usually surrounds the cæcum, but covers only the front and sides of the ascending and descending colon (p. 302). The transverse colon is encased like the stomach, and has intervals along the borders, where the transverse meso-colon and the great omentum are attached.

Two layers of fleshy fibres; longitudinal in three bands, posterior, anterior, and internal;

The *muscular coat* is formed of longitudinal and circular fibres, as in the small intestine.

The *longitudinal fibres* may be traced as a thin layer over the surface, but most are collected into three longitudinal bands, about a third of an inch in width. One of these bands is placed along the posterior or attached margin of the bowel, the other two are on the anterior and inner sides respectively. On the vermiform appendix the fibres form a uniform layer, but they are continued thence into the bands on the cæcum and colon, and on the rectum the anterior and internal bands become united. When the bands are divided the intestine elongates,—the sacculi and the ridges in the interior of the gut disappearing at the same time.

and circular.

The *circular fibres* are spread over the whole surface, but are most marked in the folds projecting into the intestine. At the end of the rectum (to be afterwards seen) they form the band of the internal sphincter muscle.

Submucous coat as in small gut.

The *fibrous* or *submucous coat* resembles that of the small intestine. It will be exposed by removing the peritoneal and muscular coverings.

Mucous coat is without folds and villi.

The *mucous coat*, which may be examined on opening the intestine, is smooth, and of a pale yellow colour; and it is not thrown into special folds. The surface is free from villi; and by this circumstance the mucous membrane of the large can be distinguished from that of the small intestine. This difference in the two portions of the alimentary tube is well marked on the ileo-colic valve; for the surface looking to the ileum is studded with villi, while the surface continuous with the mucous lining of the large intestine is free from those eminences.

Tubular glands,

Glands. The mucous membrane is thickly beset with very small

tubular glands or *crypts of Lieberkhün*, like those of the small intestine; and lymphoid nodules (solitary glands) are scattered over the whole of the large intestine, but are most abundant in the cæcum and vermiform appendix. and lymphoid nodules.

Vessels and nerves. The distribution of the vessels and nerves in the wall of the large intestine is the same as in the small. Vessels, nerves, and lymphatics.

The *absorbent vessels*, after leaving the gut, join the lymphatic glands along the side of the colon.

RELATIONS OF THE DUODENUM AND PANCREAS.

Dissection. The student should moderately inflate the stomach and duodenum from the cut extremity of the latter, and remove the loose peritoneum and the fat: while cleaning them, he should lay bare the larger vessels and nerves. Remove intestine to see the duodenum,

The stomach should be turned upwards, and the pancreas traced from the spleen on the one side to the duodenum on the other (fig. 122, p. 329), and the parts behind the stomach cleaned of their fat and peritoneum, care being taken not to injure the vessels and nerves. By pulling forwards the duodenum, the common bile-duct may be found behind, between the intestine and the head of the pancreas; and some of the pancreas will afterwards be removed, to show its duct entering the duodenum. and pancreas, with duct.

DUODENUM (figs. 121 and 122). The first part of the small intestine, or the duodenum, begins at the pyloric end of the stomach, and crossing the spinal column, ends at the duodeno-jejunal flexure on the left side of the second lumbar vertebra. It makes a curve round the head of the pancreas, and is placed mainly in the right epigastric and umbilical regions of the abdomen. From its winding course round the pancreas it is divided into four portions (fig. 121, ^{1}, ^{2}, ^{3}, and ^{4}). It may be roughly marked *on the surface of the body* by a parallelogram formed by the middle line internally, the right lateral line externally, the transpyloric line above and a line midway between the transpyloric and intertubercular lines below; it being remembered, of course, that the duodenum begins to the right of the middle line. Duodenum: extent; course and situation; division. Surface marking

The *first portion* is directed backwards and a little upwards, and is free and movable like the stomach. It measures about two inches in length, and is directed backwards from the pylorus to near the upper end of the right kidney. Above and in front are the liver and gall-bladder; below is the head of the pancreas; and behind it are the common bile-duct, the portal vein, and the gastro-duodenal artery with a portion of the head of the pancreas (fig. 123, p. 331). First part is shortest, and is movable.

The *second* or *descending portion*, about three inches in length, descends in a groove along the right border of the head of the pancreas to the level of the third lumbar vertebra, and is fixed almost immovably by the peritoneum and the pancreas. In front of it are the liver and transverse colon; behind it are the inner border of the kidney, the ureter, and the renal vessels; and on its inner side Second part is vertical and fixed.

the head of the pancreas, with the common bile-duct. The ducts of the liver and pancreas open into this part of the duodenum.

Third part is longest, and also fixed.

The *third portion* is nearly horizontal; it crosses from right to left opposite the third lumbar vertebra, in front of the vena cava and aorta. Its anterior surface is crossed from above downwards by the superior mesenteric vessels, and above it is the pancreas.

The *fourth portion* ascends on the surface of the left psoas muscle

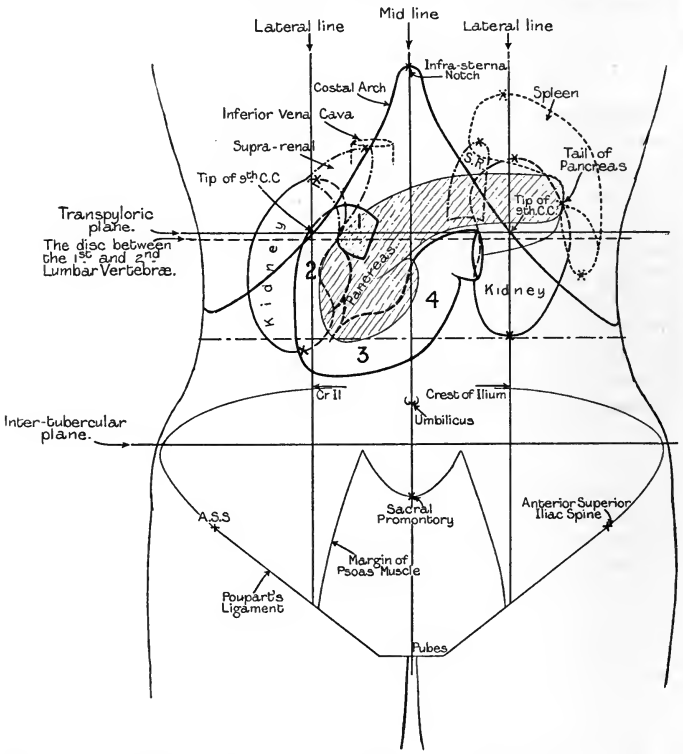


FIG. 121.—DIAGRAM SHOWING THE DISPOSITION OF THE DEEP ORGANS IN THE REGIONS OF THE ABDOMEN (C.A.).

1, 2, 3 and 4 denote the four parts of the duodenum.

Fourth part ascends.

along the left side of the aorta to the inferior surface of the pancreas, where it becomes free at the duodeno-jejunal flexure.

The DUODENO-JEJUNAL FLEXURE reaches up to the transpyloric plane a little to the left of the middle line. It is firmly held up to the inferior surface of the pancreas by a strong band of fibres—the

Suspensory ligament.

suspensory ligament (Lockwood)—which passes upwards behind the pancreas. In the child this band consists largely of unstriped muscle fibres, and is readily defined. It passes upwards to the left of the cœliac axis, and blends with the diaphragm to the right of the œsophageal opening.

The peritoneal relations of the duodenum have been noticed at p. 301.

Pancreas (fig. 122 and fig. 123, p. 331). The pancreas is situate behind the stomach, extending from the duodenum to the spleen, and occupying parts of the right umbilical, the epigastric, and the left hypochondriac regions. In form it is elongated, with its right portion much expanded from above down, constituting the head; this part lies in front of the first and second lumbar vertebræ, the great vessels and muscles intervening. Pancreas: situation and form;

The gland has a massive *head* embraced by the duodenum, a *neck* or head,

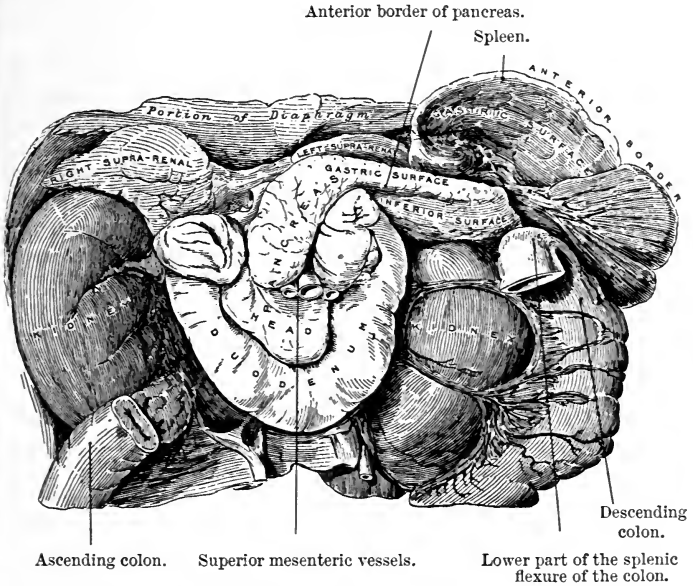


Fig. 122.—Deep Viscera of the Abdomen of a Child.
(From a specimen in the Charing Cross Hospital Museum.)

slight constriction near the middle line, usually above the convergence of the mesenteric vessels, and a *body* extending across to the left as far as the spleen. The left extremity of the body is commonly spoken of as the *tail*, but the gland is often not at all tapering in this part. body tail.

The body has usually somewhat of a twist upon it as it passes to the left (fig. 123); and it presents an anterior or *gastric* surface, an inferior or *jejunal* surface, and a *posterior*. These surfaces are separated by upper, anterior, and lower borders. Surfaces:

The transverse meso-colon springs from its anterior border; the upper layer of the peritoneum passes upwards over the gastric surface, and the lower layer is directed backwards across the inferior surface.

anterior surface,

Its *anterior surface* is for the most part concave, corresponding to the stomach; but at its upper border, in front of the vertebral column, it forms a projection (*omental tuberosity*, His) opposite the small curvature and lesser omentum.

inferior,

Its *inferior surface* is in contact with the duodeno-jejunal flexure and coils of the jejunum, as well as sometimes at its left extremity with the splenic flexure of the colon.

posterior.

Its *posterior surface* rests on the vena cava, the termination of the right renal vein, the aorta, the solar plexus, the pillars of the diaphragm, the left kidney, and the lower part of the left suprarenal body with the renal and suprarenal vessels. The splenic vein and the beginning of the vena portæ lie also behind it, and are often somewhat embedded in its substance.

Relations to vessels.

Projecting above the pancreas, where it crosses the aorta, is the cœliac axis, from which the splenic artery runs to the left along the upper border (fig. 123); while on the right side the hepatic artery and the first part of the duodenum lie above it. At the lower border is the third part of the duodenum; and the superior mesenteric vessels emerge between the two, usually passing in front of a portion of pancreatic substance (*lesser pancreas*) (fig. 122) which extends more or less over the front of the fourth part of the duodenum, occasionally even reaching into the root of the mesentery.

The common bile-duct lies between the duodenum and the head of the pancreas for a short distance behind, and will be traced out later.

THE STOMACH BED (FIG. 122).

Stomach bed.

With the stomach lifted well up and the parts behind it exposed, the student will realise the character of the hollow in which it lies to the left of the vertebral column. The floor of the stomach bed (Birmingham) is formed (1) internally by the diaphragm covering the vertebral column and (2), further outwards and above, by the gastric surface of the spleen. Below this is (3) a portion of the left suprarenal body resting against the crus of the diaphragm, and, it may be, (4) a small part of the left kidney above the pancreas (fig. 121). Below these is (5) the gastric surface of the pancreas, which, in passing to its prominent anterior border, forms the commencement of a shelf supporting the stomach below; and the shelf is completed by (6) the transverse meso-colon passing forwards and downwards from the anterior border of the pancreas to (7) the transverse colon. This shelf is itself supported by the small intestines below the transverse meso-colon.

Variations in the shape and position of the pancreas.

The shape of the body of the pancreas is much determined by the pressure of the stomach above and that of the small intestines below. When the stomach is low and distended the pancreas becomes flattened out and pushed down on the left kidney. On the contrary, when the stomach is high up and the small intestines distended, the pancreas becomes pushed up and its anterior border more prominent.

CŒLIAC AXIS AND PORTAL VEIN.

A short branch of the aorta—the cœliac axis—furnishes arteries to the stomach and duodenum, the liver, pancreas, and spleen : it subdivides into three primary branches—coronary, hepatic, and splenic. Arteries of viscera.

The veins corresponding to the arteries (except the hepatic) are collected into one trunk—the vena portæ. Veins.

Dissection. The vessels have been in part laid bare by the previous dissection, and in tracing them out fully the student should spare the nerve-plexuses around them. Supposing the liver well raised, he may first follow to the left side the small coronary artery, and show its branches to the œsophagus and the stomach. How to dissect cœliac axis, and branches, coronary,

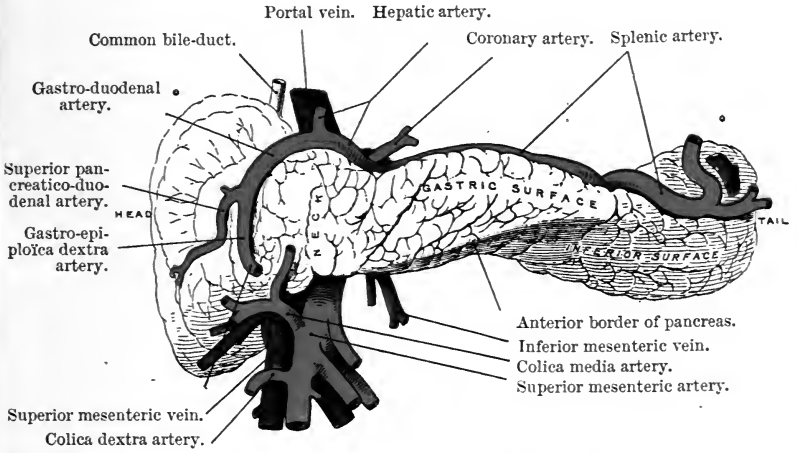


FIG. 123.—THE PANCREAS AND THE BLOOD-VESSELS IN RELATION WITH IT.

(From a specimen in the Charing Cross Hospital Museum.)

Next, the hepatic artery, with the portal vein and the bile-duct, may be traced to the liver and the gall-bladder ; and a considerable branch of the artery should be pursued beneath the pylorus to the stomach, duodenum, and pancreas. Lastly, the splenic artery, which lies along the upper border of the pancreas, is to be cleaned ; and its branches to the pancreas, stomach, and spleen should be defined. In doing this one student should hold aside the stomach and spleen whilst the other does the dissection. hepatic, and splenic.

The veins will be dissected for the most part with the arteries ; but the origin of the portal trunk is to be made out beneath the pancreas, and in front of the vena cava. Veins.

The CŒLIAC AXIS (fig. 124, p. 333) is the first visceral branch of the abdominal aorta, and arises close to the upper margin of the opening in the diaphragm. It is a short thick trunk, about half an inch long, which projects above the upper border of the pancreas, Cœliac axis supplies the three following :—

and is surrounded by the solar plexus of the sympathetic. Its branches—coronary, hepatic, and splenic—radiate from the trunk (whence the name axis) to their distribution to the surrounding viscera (see also fig. 123).

Coronary, which gives

The CORONARY ARTERY (fig. 124 *d*) is the smallest of the three, and runs upwards between the peritoneum and diaphragm to the cardiac orifice of the stomach. Having furnished some œsophageal branches, it bends downwards, and passes between the layers of the small omentum, along the small curvature of the stomach, to anastomose with the pyloric branch (*o*) of the hepatic artery. Its offsets are thus distributed :—

offsets to the œsophagus

a. Œsophageal branches ascend on the gullet through the opening in the diaphragm, and anastomose with branches of the descending thoracic aorta.

and the stomach.

b. Gastric branches are given to both sides of the stomach, and those on the left end communicate with twigs (vasa brevia) of the splenic artery.

Splenic artery

The SPLENIC ARTERY (*e*) is the largest branch of the cœliac axis in the adult. It is a tortuous vessel, and runs almost horizontally to the spleen along the upper border of the pancreas (fig. 123). Near the spleen it divides into terminal branches, about seven in number (from four to ten), which enter that viscus by the surface towards the stomach. It is accompanied by the splenic vein, which is below it ; and it distributes branches to the pancreas and the stomach.

supplies the spleen,

the pancreas by large and small twigs,

a. Pancreatic branches. Numerous small branches are supplied to the pancreas ; and one of these (*arteria pancreatica magna*) sometimes arises near the left end and runs to the right in the gland with the duct ; but this artery is usually not larger than some others.

and the stomach by vasa brevia,

and left gastro-epiploïc.

b. Gastric branches arise from the artery or its divisions near the spleen, and pass to the stomach between the layers of the gastro-splenic omentum. Most of these (*vasa brevia*) are small, and ramify over the left end of the organ ; but one larger branch, the *left gastro-epiploïc artery* (*f*), turns to the right between the layers of the great omentum, along the great curvature of the stomach, and inosculates with the right gastro-epiploïc branch of the hepatic artery. This artery distributes twigs to both surfaces of the stomach, and between the pieces of peritoneum forming the great omentum.

Hepatic artery courses to the liver,

in which it ends,

and supplies

The HEPATIC ARTERY (*g*) is intermediate in size between the other two, and is encircled by the largest plexus of nerves. In its course to the liver, the vessel is directed at first to the right and forwards to the pyloric end of the stomach, where it supplies its gastric branches. It then ascends between the layers of the small omentum, on the left side of the bile-duct and portal vein, and divides near the transverse fissure of the liver into two—the right and left hepatic. *Branches* are distributed not only to the liver, but also to the stomach, the duodenum, and the pancreas, as below :—

offsets to

a. The *gastro-duodenal artery* (figs. 123 and 124) is a short vessel which descends beneath the duodenum near the pylorus, and divides into the two following branches :—

The *right gastro-epiploïc artery* (fig. 124 *h*) is the continuation of the gastro-duodenal trunk, and runs from right to left along the great curvature of the stomach. It gives offsets upwards to the surface of the stomach, and downwards to the great omentum, and ends by inosculating with the left gastro-epiploïc artery. stomach,

The *superior pancreatico-duodenal artery* (*i*) is of small size, and descends between the duodenum and pancreas to join the inferior pancreatico-duodenal branch of the superior mesenteric. Offsets are given to both the viscera; and on their posterior aspect is another duodenum and pancreas.

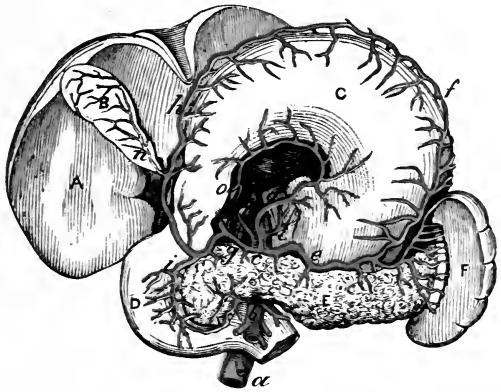


FIG. 124.—VIEW OF THE CŒLIAC AXIS, AND OF THE VISCERA TO WHICH ITS BRANCHES ARE SUPPLIED (TIEDEMANN).

A. Liver.
B. Gall-bladder.
C. Stomach.
D. Duodenum.
E. Pancreas.
F. Spleen.

Arteries:

a. Aorta.
b. Upper mesenteric.
c. Cœliac axis.
d. Coronary.
e. Splenic.
f. Left gastro-epiploïc.
g. Hepatic.
h. Right gastro-epiploïc.
i. Superior, and *k*, inferior pancreatico-duodenal.
l. Phrenic.
n. Cystic.
o. Pyloric.

small artery of the pancreatico-duodenal, with a similar position and distribution.

b. The *pyloric branch* (*o*) descends to the small curvature of the stomach, and, running from right to left, anastomoses with the coronary artery; it distributes small twigs on both surfaces of the stomach.

The *hepatic branches* sink into the liver at the transverse fissure, and ramify in its substance:— Branches to the liver,

c. The *right branch* is divided when about to enter the organ, and supplies the following small artery to the gall-bladder. one for the right lobe and gall-bladder,

The *cystic artery* (*n*) bifurcates on reaching the neck of the gall-bladder, and its two twigs ramify on the upper and lower surfaces.

d. The *left branch* is smaller than the other, and enters the liver and one for the left lobe.

at the left end of the transverse fissure; a branch to the Spigelian lobe of the liver arises from this piece of the artery.

Dissection. The veins forming the portal will now be exposed by raising up the pancreas from the left, as may be required.

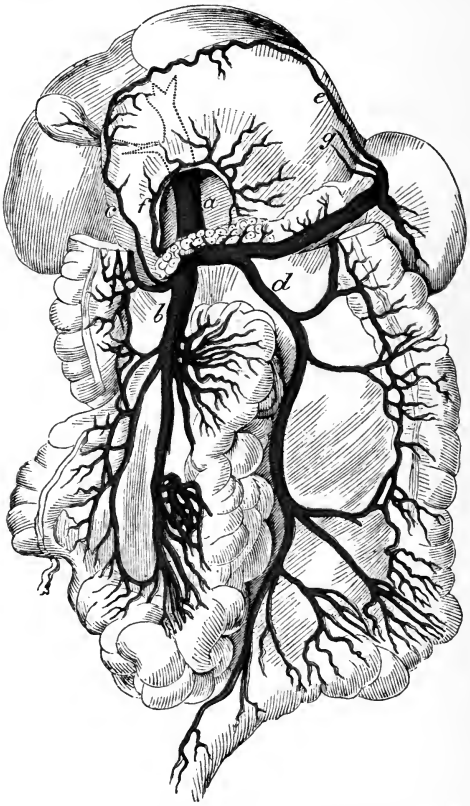


FIG. 125.—PORTAL VEIN AND TRIBUTARIES (HENLE).

a. Trunk of the portal vein.
b. Upper mesenteric.
c. Right gastro-epiploïc.
d. Inferior mesenteric.
e. Left gastro-epiploïc.
f. Pyloric (in this case of large size).
g. Venæ breves.

The splenic vein is not indicated by a letter.

Portal system of veins.

PORTAL VEIN. The veins of the stomach and intestine, and of the spleen and pancreas, pour their blood into the vena portæ. The two mesenteric veins and their branches have been referred to (pp. 316 and 318); and the three following, with the trunk of the portal vein, remain to be noticed.

Coronary vein.

The *coronary vein* accompanies the artery of the same name along the small curvature of the stomach, and bending downwards at the cardia, passes to the lower end of the portal vein or the adjacent part of the splenic vein.

The *pyloric vein* (fig. 125, *f*) lies with the pyloric branch of the hepatic artery along the lower part of the small curvature of the stomach, and opens into the portal vein opposite the duodenum. Pyloric vein.

The *splenic vein* (fig. 125) is of large size, and is formed by the union of branches from the spleen. It runs below the artery, and under cover of the pancreas, to the front of the vena cava, where it joins the superior mesenteric vein (*b*) to form the vena portæ. Splenic vein:

Between its origin and termination it receives branches corresponding with the following arteries,—vasa brevia (*g*), left gastro-epiploïc (*e*), and pancreatic. The inferior mesenteric and coronary veins (*d*) sometimes open into it. tributaries.

The PORTAL VEIN (vena portæ, fig. 125, *a*, also fig. 123) is formed by the union of the splenic and superior mesenteric veins. Its origin is placed behind the head of the pancreas, and in front of the inferior vena cava. The vessel is about three inches long, and ascends beneath the first part of the duodenum, and then between the layers of the small omentum, to the transverse fissure of the liver, where it divides into a right and a left branch. While in the small omentum it lies behind the hepatic artery and bile-duct. Portal vein: origin; course and relations;

The *right branch* is shorter and larger than the left, and ramifies in the right lobe of the liver. branches;

The *left branch* gives an offset to the Spigelian lobe, and enters the left half of the liver.

In its course the portal trunk is joined by the coronary and pyloric veins from the stomach; and the *cystic vein* from the gall-bladder enters the right branch. and tributaries.

This vein commences by tributaries from the viscera of the abdomen, like any other vein; but it has no valves, and it ramifies through the structure of the liver in the same manner as an artery. Its radicles communicate with the systemic veins on some parts of the intestinal tube, but more particularly on the rectum. Peculiarities of portal vein.

Dissection. The common bile-duct will now be traced upwards and downwards, the duodenum being raised up from the right and thence to the left as required.

BILE-DUCTS. Two *hepatic ducts* issue at the transverse fissure of the liver (fig. 131, p. 346), one from the right and the other from the left lobe, and unite to form the following:— Right and left hepatic ducts.

The *common hepatic duct* is an inch and a half long, and receives at its termination the duct of the gall-bladder, the union of the two giving origin to the common bile-duct. Common hepatic duct.

The *common bile-duct* (fig. 131, *bd*) is about three inches long. It descends almost vertically beneath the upper portion of the duodenum; then passing between the pancreas and the second piece of the duodenum, it opens into this portion of the intestine at the inner side, and about the middle. While in the small omentum the duct lies to the right of the hepatic artery, and somewhat before the portal vein. Common bile-duct: length and course; termination;

As it pierces the wall of the intestine it is joined commonly by the pancreatic duct, but the two may enter the duodenum separately. joined by pancreatic.

SYMPATHETIC AND VAGUS NERVES.

General disposition of nerves.

SYMPATHETIC NERVE. In the abdomen, as in the thorax, the sympathetic nerve consists of a gangliated cord on each side of the vertebral column, and of prevertebral centres or plexuses, which furnish branches to the viscera.

Two large centres, epigastric and hypogastric.

The chief prevertebral plexuses in the abdomen are the epigastric or solar and the hypogastric. The epigastric plexus is placed behind the stomach, and supplies nerves to all the viscera above the cavity of the pelvis: it is continued downwards to the hypogastric plexus by the aortic plexus (p. 319). The hypogastric plexus distributes nerves to the pelvic viscera, and has already been noticed at its commencement (p. 319).

The knotted or gangliated cord will be met with in a subsequent stage of the dissection; and only the great solar plexus with its offsets is to be now examined.

How to lay bare solar plexus,

Dissection. To denude the epigastric plexus, the following dissection is to be made: The air should be let out of the stomach and duodenum; the portal vein, the common bile-duct, and the gastro-duodenal artery are to be cut through near the pylorus; and the stomach, duodenum, and pancreas are to be drawn over to the left side. On raising the liver, the vena cava appears; this is to be cut across above the junction of the renal veins with it, and the lower end is to be drawn down with hooks.

and the semilunar ganglia.

Beneath the vein the dissector will find the large reddish semilunar ganglion of the right side; and mixed up with the nerves of the plexus are numerous lymphatic glands (cœliac glands), with a dense tissue, which require to be removed with care. From its inner part he can trace the numerous nerves and ganglia around the cœliac and superior mesenteric arteries, and the secondary plexuses on the branches of those arteries. From the outer part of the ganglion offsets are to be followed to the kidney, the suprarenal body, and the diaphragmatic arteries. At its upper end the junction with the large splanchnic nerve may be seen; and deeper than the last, one or two smaller splanchnic nerves may be found as they issue through a fissure of the diaphragm, and enter the cœliac, renal and suprarenal plexuses.

Follow the ending of the vagus nerves.

The student should then trace the ending of the pneumo-gastric nerves on the stomach. The left nerve will be found at the small curvature in front, near the œsophagus; and the right nerve will be seen at a corresponding spot on the opposite aspect. Branches from the right nerve are to be followed to the plexus of the sympathetic by the side of the cœliac axis; and from the left, to the hepatic plexus.

Solar plexus: appearance and extent;

The EPIGASTRIC OR SOLAR PLEXUS is a large network of nerves and ganglia, which lies in front of the aorta and pillars of the diaphragm, and behind the pancreas and inferior cava: it fills the space between the suprarenal capsules of opposite sides, and surrounds the cœliac axis and the superior mesenteric artery. The

plexus is connected on each side with the large and small splanchnic nerves; and it is joined also by a great part of the right pneumo-gastric nerve. Large branches are furnished to the different viscera along the vessels. gives offsets on blood-vessels.

The *semilunar ganglia*, one in each half of the plexus, are the largest in the body, and are placed close to the suprarenal capsules, resting on the diaphragm, the ganglion of the right side being beneath the vena cava. At the upper end each is joined by the great splanchnic nerve. Each ganglion is irregular in shape, and is often divided into smaller ganglia; from its outer side nerves are directed to the kidney and the suprarenal capsule. Semilunar ganglia: situation; form.

Offsets of the plexus. The nerves supplied to the viscera form plexuses round the vessels; thus, there are cœliac, mesenteric, renal, spermatic, diaphragmatic plexuses, &c. Several offsets of the plexus.

The *diaphragmatic* or *phrenic plexus* comes from the upper end of the semilunar ganglion, but it soon leaves the phrenic artery to enter the substance of the diaphragm: a communication takes place between the phrenic nerve from the cervical plexus and these branches of the sympathetic. On the right side is a small ganglion where the plexus is joined by the spinal nerve; and from it filaments are supplied to the vena cava and the suprarenal body: this ganglion is absent on the left side (Swan). Plexus to the diaphragm has a ganglion on right side.

The *suprarenal nerves* are very large and numerous, in comparison with the size of the viscus supplied, and are directed outwards to the suprarenal body. The lesser splanchnic nerve directly communicates with this plexus. Suprarenal nerves.

The *renal plexus* is derived from the semilunar ganglion and outer side of the solar plexus, and is joined by the smallest splanchnic nerve. The nerves surround the renal artery, having small ganglia on them, and enter the kidney with the vessels. An offset is given from the renal to the spermatic plexus (p. 319). Renal plexus.

The *cœliac plexus* is a direct continuation of the plexus around its artery: it is joined by the small splanchnic nerve on each side, and by a branch from the right pneumo-gastric nerve. The plexus divides like the artery into three offsets—coronary, splenic, and hepatic. Cœliac plexus divides like the artery,

a. The *coronary plexus* accompanies the vessel of the same name to the stomach: it communicates with the left vagus nerve. into coronary,

b. The *splenic plexus* furnishes nerves to the pancreas, and to the stomach along the left gastro-epiploïc artery; and it is joined by an offset from the right pneumo-gastric nerve. splenic,

c. The *hepatic plexus* is continued on the vena portæ, the hepatic artery, and the bile-duct into the liver, and ramifies on those vessels: in the small omentum the plexus is joined by offsets from the left vagus. The following secondary plexuses are furnished around the branches of the hepatic artery, and have the same name and distribution as the vessels: and hepatic; the last has secondary plexuses, viz.,

A *pyloric plexus* courses along the small curvature of the stomach. pyloric,

gastro-epiploïc, duodenal, and cystic. Two other plexuses—*right gastro-epiploïc* and *pancreatico-duodenal*, correspond in distribution with the branches of each artery.

A *cystic plexus* passes to the gall-bladder with the artery.

The remaining offsets of the plexus, viz., superior and inferior mesenteric, aortic, and spermatic, have been already noticed (p. 319); but the derivation of the superior mesenteric and aortic plexuses from the epigastric centre can now be seen.

Ending of large splanchnic nerve, *Ending of the splanchnic nerves.* The *large nerve* perforates the crus of the diaphragm, and generally ends altogether in the semi-lunar ganglion.

small, The *small nerve* comes through the same opening in the diaphragm as the preceding, and joins the cœliac plexus.

and smallest. The *smallest nerve*, which is often absent, passes into the supra-renal and renal plexuses.

ENDING OF THE VAGUS NERVE. The pneumo-gastric nerves pass on to the stomach :—

Ending of left vagus The *left nerve* divides into branches, which extend along the small curvature, and over the front of the stomach and sends offsets to the hepatic plexus.

and right. The *right nerve* is distributed to the posterior surface of the stomach near the upper border; it communicates with its fellow, and gives branches to the cœliac and splenic plexuses.

REMOVAL OF THE STOMACH AND OTHER VISCERÆ.

Dissection. The œsophagus should be cut through as it pierces the diaphragm and the stomach, duodenum, pancreas and spleen are to be removed by cutting through the vessels and nerves left passing to them.

THE STOMACH.

Definition. The stomach is the dilated part of the alimentary tube between the œsophagus and the small intestine, into which the masticated food is received.

Separate and blow up the stomach. **Dissection.** The stomach and duodenum must be blown up moderately with air, and the surfaces cleaned; but, previously, let the student detach the spleen and put it aside.

Form, FORM AND DIVISIONS. The stomach is rather pyriform in shape, and in its natural condition strongly curved with its surfaces looking, one upwards and forwards, and the other downwards and backwards. Its size varies much in different bodies, and is sometimes much diminished by a constriction to the right of the centre: when it

size, and divisions. is moderately distended, it is about twelve inches long and four wide. There are two ends, two orifices, two surfaces, and two borders or curvatures to be examined.

Left end, The left end is called the *fundus*, and projects upwards to the *summit* to the left of the end of the œsophagus (fig. 110, p. 301).

and right. The right or *pyloric end* is much smaller, and tapers to the duodenum. The stomach is usually narrow and cylindrical a

short distance before the pylorus, and the constricted part is styled the *pyloric canal* (Jonnesco).

The *cardiac opening*, which communicates with the œsophagus, is placed two or three inches from the most prominent part of the fundus, and is funnel-shaped towards the cavity of the organ. The *pyloric orifice* opens into the duodenum, and is guarded internally by a muscular band (pylorus), at this spot the stomach is slightly constricted externally, and a firm circular thickening can be felt. Cardiac and pyloric openings.

The anterior, or upper, and the posterior, or lower, surfaces are somewhat flattened when the viscus is empty, but round when it is distended, and the parts in contact with them have been referred to (p. 300). Surfaces.

The upper border or *lesser curvature* is concave, except for a short distance at the pyloric end. The lower border or *greater curvature* is Small curvature,

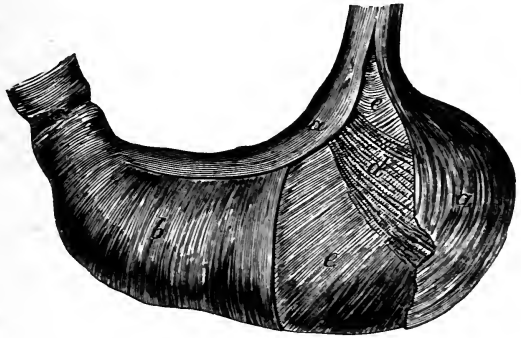


Fig. 126.—Diagram of the Muscular Fibres of the Stomach.

The external and middle layers are partly removed.

a. External or longitudinal fibres.
b. Middle or circular.
c. Sphincter of the pylorus.
d. Oblique fibres on the right of the cardiac opening.
e. Oblique fibres, more numerous, on the left of the cardiac orifice, and covering the great end of the stomach.

much longer, convex, and when the organ is distended forms at the pyloric end a slight projection to the right, which has been named the *antrum pylori* or *small cul-de-sac*. and large.

Structure. In the wall of the stomach are four coats, viz. serous, muscular, fibrous, and mucous; and belonging to these there are vessels, nerves, and lymphatics. Four strata in stomach.

Serous coat. The peritoneum gives a covering to the stomach, and is adherent to the surface except at each margin, where an interval exists corresponding with the attachment of the small and large omentum: in these spaces are contained the vessels, nerves, and lymphatics. During distension of the stomach the spaces above mentioned are much diminished. The serous coat is thin and adherent.

The muscular coat is made up of

The *muscular coat* will be laid bare by the removal of the serous covering. Its fibres are unstriated or involuntary, and arranged in three sets, viz., longitudinal, circular, and oblique, in the order mentioned from without inwards.

longitudinal,

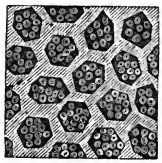
The *longitudinal fibres* (fig. 126, *a*) are derived from the œsophagus; they spread over the surface, and are continued to the pylorus and the small intestine. The fibres are most marked along the borders, particularly at the smaller one; and at the pylorus they are stronger than in the centre of the stomach.

circular,

The *circular fibres* (fig. 126, *b*) form the middle stratum, and will be best seen by removing the longitudinal fibres near the pylorus. They reach from the left to the right end of the stomach, but do not encircle the fundus. At the pylorus they are most numerous and strongest, and form a ring or sphincter (*c*) round the opening.

and oblique fibres.

The *oblique fibres* (fig. 126, *e*) are continuous with the circular or deep layer of fibres of the œsophagus. On the left and right of the cardiac orifice they are so arranged as to form a kind of sphincter (*d* and *e*) (Henle); those on the left (*e*), the strongest, arch over the great end of the stomach, and spread out on the anterior and posterior surfaces, gradually disappearing on them.



The fibrous coat is thin but firm.

FIG. 127.—ALVEOLAR DEPRESSIONS OF THE MUCOUS MEMBRANE OF THE STOMACH, MAGNIFIED 32 DIAMETERS, WITH THE MINUTE TUBES OPENING INTO THEM (SPROTT BOYD).

Dissection. Remove the muscular layers over a small space and the *fibrous* or *submucous coat* will appear as a white shining stratum of areolar tissue. This coat gives strength to the stomach, and serves as a bed in which the larger vessels and nerves ramify before their distribution to the mucous layer. If a small opening be made in this submucous coat, the mucous coat will project through it. Finally the stomach should be opened along the lesser curvature to near the pylorus. The finger should be passed through the pylorus to feel its sphincter, and then the incision should be continued through the pylorus and along the convexity of the duodenum to its termination.

Mucous coat:

The *mucous coat* will come into view, but the appearances now described can be recognised only in a recent specimen, or in one well preserved by formalin injection.

feel and colour;

This coat is a softish layer, of a pale rose colour soon after death, in the healthy condition. In the empty state of the stomach the membrane is less vascular than during digestion; and in infancy the natural redness is greater than in childhood or old age. When the

folds;

stomach is contracted the membrane is thrown into numerous wavy ridges or *rugæ*, which become longitudinal along the great curvature, towards the pylorus.

thickness; disposition at pylorus.

The thickness of the mucous membrane is greatest near the pylorus; and at that spot it forms a fold, opposite the muscular

ring, which assists in closing the opening. If this membrane and the submucous layer are removed from the pyloric part of the stomach, the ring of muscular fibres (sphincter of the pylorus) will be more perfectly seen.

With the aid of a lens, the surface of the mucous membrane, when well washed, may be seen to be covered by shallow depressions or alveoli (fig. 127), which measure from $\frac{1}{200}$th to $\frac{1}{100}$th of an inch across. Generally hexagonal or polygonal in outline, the hollows become larger and more elongated towards the small end of the stomach; and near the pylorus the margins of the alveoli project, and become irregular. In the bottom of each depression are the apertures of minute tubular glands. On the surface are pits or alveoli; their size, shape, and appearance.

Blood-vessels. The *arteries* of the stomach are derived from the branches of the cœliac axis, and have been seen to form an arch along each curvature (pp. 332 *et seq.*). From these arches branches pass to both surfaces of the stomach, and after supplying the muscular coats divide in the submucous layer into minute vessels which enter the substance of the mucous membrane. The *veins* have a corresponding arrangement, and pass to the portal system (p. 334). Arteries; veins;

Lymphatics. The lymphatic vessels proceeding from the stomach run with the blood-vessels, and have a few small glands connected with them along the two curvatures. lymphatics;

Nerves. The nerves are derived from the pneumo-gastric and sympathetic, and can be followed to the fibrous coat: small ganglia have been observed on them. and nerves.

THE DUODENUM AND PANCREAS DISSECTED.

Dissection. The duodenum will now be washed and its mucous surface examined. The commencement of the valvulæ conniventes one or two inches from the pylorus will be noticed, and the opening of the biliary and pancreatic ducts examined.

The *aperture of the common bile and pancreatic ducts* (fig. 128, *e*) is a narrow orifice, from three to four inches below the pylorus, and situate in a small prominence of the mucous membrane, at the inner and posterior part of the duodenum. A probe passed into the bile-duct will show its oblique course (half an inch or more) under the mucous coat. Occasionally the pancreatic duct opens by a distinct orifice. Opening of bile-duct; where situate.

Structure of the common bile-duct. The bile-duct consists of an external, strong fibrous layer, and of an internal mucous coat. On the surface of the inner membrane are the openings of numerous branched mucous glands, which are embedded in the fibrous coat; some of them are aggregated together, and are visible with a lens. Two coats in the bile-duct; glands.

The coats of the duodenum are like those of the rest of the small intestine (pp. 321 *et seq.*), but Brunner's glands should be noticed.

The *Glands of Brunner* are small compound bodies, similar to the buccal and labial glands of the mouth, which exist in the duodenum. They are most numerous for a distance of one or two inches near Glands of Brunner.

the pylorus, and there they are visible without a lens, being nearly as large as hemp-seed and appear lost after removal of the muscular coat.

Trace out the duct.

Dissection. The pancreas should now be placed on its anterior surface, and the excretory duct traced from the head to the tail by cutting away the substance of the gland. The duct will be recognised by its whiteness.

It is a compound gland, without a distinct capsule.

Structure. The pancreas resembles the parotid gland in structure, consisting of separate lobules, each of which is provided with a special duct. It is destitute of a distinct capsule; but it is surrounded by areolar tissue, which projects into the interior, and connects together its smaller pieces. The lobules are soft and loose, and of a

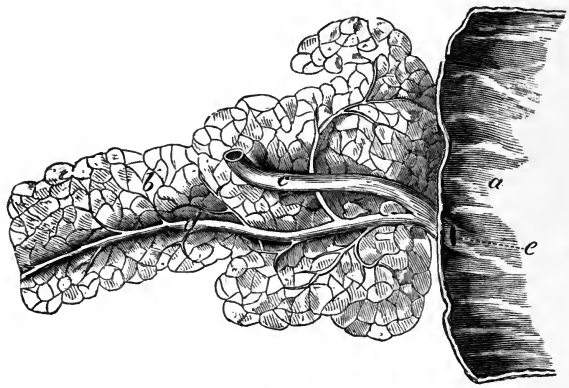


Fig. 128.—A Small Piece of the Duodenum opened, with a part of the Pancreas, showing the Termination of the Bile and Pancreatic Ducts (Henle).

a. Duodenum.
b. Pancreas.
c. Common bile-duct.
d. Pancreatic duct.
e. Common opening of the ducts in the intestine.

greyish white colour, and are united into larger masses by areolar tissue, vessels, and ducts.

The duct of the gland:

The *duct* of the pancreas (canal of Wirsung; fig. 128, *d*) extends the whole length of the gland, and is somewhat nearer the lower than the upper border. It begins in the tail of the pancreas, where it presents a bifurcated extremity; and as it continues onwards to the head, it receives many branches. It is readily recognised from its whiteness on dividing the gland longitudinally. Of the tributary branches, the largest is derived from the lower part of the head of the pancreas.

extent;

branches;

An *accessory duct* is often found a short distance above the main one.

size and structure.

The duct measures from $\frac{1}{15}$th to $\frac{1}{10}$th of an inch in diameter near the duodenum. It is formed of a fibrous coat with a very smooth mucous lining.

Vessels, lymphatics, and nerves. The arteries and veins have been described (pp. 332 *et seq.*); and the lymphatics pass to the cœliac glands. The nerves are furnished by the solar plexus. Vessels and nerves.

THE SPLEEN.

The spleen is a vascular spongy organ of a bluish or purple colour, sometimes approaching to grey. Its texture is friable, and easily broken under pressure. Consistence and colour.

The viscus is somewhat elliptical in shape, and is placed obliquely behind the great end of the stomach. Its size varies much. In the adult it measures commonly about five inches in length, three or four inches in breadth, and one inch to one inch and a half in thickness. Its weight lies between four and ten ounces, and is rather less in the female than the male. Its relations are described on p. 306. Form and position. Size and weight.

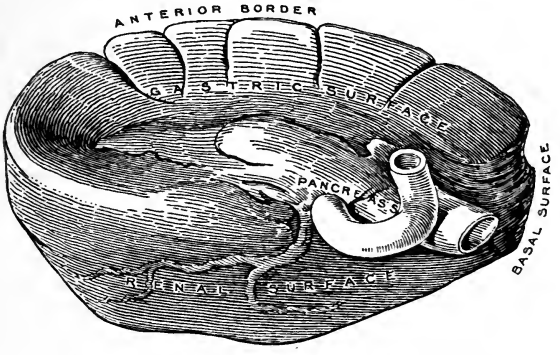


Fig. 129.—The Spleen, seen from the Right.

At the outer or phrenic aspect it is convex towards the ribs. On the opposite side a longitudinal ridge separates an anterior or gastric surface from a narrow internal or renal surface, both of which are concave. Just in front of the ridge is a groove, or more commonly a series of small depressions, where the branches of the vessels enter: this part is called the *hilum* of the spleen. Surfaces are phrenic, gastric, and renal.

The anterior border is thinner than the posterior, and is often notched. Of the two extremities, the lower is more pointed than the upper. Borders and extremities.

Small masses of splenic substance, or *accessory spleens* (spleniculi), varying in size from a bean to a moderate-sized plum, are found occasionally, near the hilum of the spleen, in the gastro-splenic omentum, or in the great omentum. Sometimes accessory spleens.

Structure. Enveloping the spleen are two coverings, a serous and a fibrous, and the spleen itself is formed of a network of fibrous or trabecular tissue, which contains in its meshes the splenic pulp. Throughout the mass the blood-vessels and the nerves ramify. It has no duct. Two coats and special material.

Serous coat nearly complete.

The *serous* or *peritoneal coat* encases the spleen, covering the surface except at the hilum and the ridge behind. It is closely connected to the subjacent fibrous coat.

Fibrous coat sends inwards processes,

The *fibrous coat* (tunica propria) gives strength to the spleen, and forms a complete case for it. At the hilum this investment passes into the interior with the vessels, to which it furnishes sheaths; and if an attempt is made to detach this coat, numerous fibrous processes will be seen to be connected with its deep surface.

structure.

Its colour is whitish; and it is made up of areolar and elastic tissues.

Interior of spleen,

Dissection. The spongy or trabecular structure will best appear by washing and squeezing a piece of fresh bullock's spleen under water, so as to remove the inner grumous-looking material.

disposition of fibrous tissue

to form an areolar structure.

The *trabecular tissue* (fig. 130) forms a network through the whole interior of the spleen, similar to that of a sponge, which is joined to the external casing, and forms sheaths around the vessels. Its processes or threads are white, flattened or cylindrical, and consist of fibrous and elastic tissues, with a few muscular fibres. The interstices communicate freely together, and contain the pulp of the spleen.

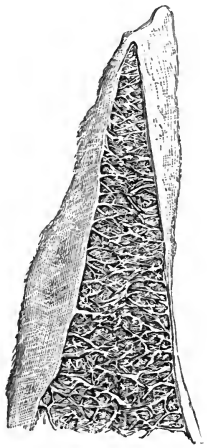


FIG. 130.—TRABECULAR STRUCTURE OF THE SPLEEN OF THE OX.

Pulp of spleen.

The *splenic pulp* is a soft red-brown mass, which is lodged in the areolæ of the trabecular structure, and consists in great part of blood. In a fresh section small whitish spots ($\frac{1}{60}$th of an inch in diameter) may be seen scattered amongst the dark pulp: these are the *Malpighian corpuscles* of the spleen—lymphoid nodules attached to the small branches of the artery.

Malpighian bodies.

Splenic artery:

Blood-vessels. The larger branches of the *splenic artery* are surrounded by sheaths of fibrous tissue in the trabeculæ; but the

ending;

smallest branches leave the sheathing, and break up into tufts of capillaries, which are said to open into the fine meshes of the

no anastomoses.

spleen substance. There are few or no anastomoses between the arterial branches in the organ.

Vein begins by open spaces;

The *splenic vein* is supposed to begin in the meshes of the splenic pulp by open channels. The small branches resulting from the

branches anastomose.

union of these radicles anastomose freely together, and unite into trunks larger than the accompanying arteries, which issue by the hilum of the spleen.

Lymphatics

Lymphatics and nerves. The *lymphatics* are superficial and deep, and, leaving the organ at the hilum, traverse small glands lying along the splenic vessels on their way to the cœliac glands. The

Nerves.

nerves come from the solar plexus, and surround the artery and its branches.

REMOVAL OF THE LIVER

Dissection. The liver should now be removed from the abdomen, in order that it may be more particularly examined. Begin in front by cutting through the round and falciform ligaments. Then, drawing the liver downwards, cut through the long left lateral ligament and the short right one, and the upper layer of the coronary ligament, taking care not to cut the diaphragm. Beyond the upper layer of the coronary ligament there is an area over which the posterior surface of the liver is not covered by peritoneum, but is simply bound to the diaphragm by areolar tissue, and from which it can be separated by the handle of the scalpel. The inferior vena cava, as it leaves the liver to pierce the diaphragm, will now be exposed, and it must be cut across. Finally, the lower layer of the coronary ligament will be divided, and the liver will come away with a portion of the inferior cava embedded in it, as that vessel had been divided already before its entry into the liver.

THE LIVER.

Office of the liver.

The liver secretes the bile, and is the largest gland in the body. Its duct opens into the duodenum with that of the pancreas.

Clean vessels on under surface;

Dissection. Preparatory to examining the liver, the vessels at the under surface should be dissected out (fig. 131, p. 346). This proceeding will be facilitated by distending the vena cava and vena portæ with tow or cotton-wool, and the gall-bladder with air through its duct. The several vessels and the ducts are then to be defined, and the gall-bladder is to be cleaned.

follow left piece of vena portæ.

On following outwards the left branch of the portal vein to the longitudinal or antero-posterior fissure, it will be found united anteriorly with the round ligament (*c*) or the remains of the umbilical vein, and posteriorly with the thin fibrous remnant of the ductus venosus (*d*).

Colour and consistence; weight; measurements.

The LIVER is of a red-brown colour and firm consistence, and weighs commonly in the adult from three to four pounds. Transversely the gland measures from ten to twelve inches; from front to back between six and seven inches; and in thickness, at the right end, about three inches, but this last measurement varies much with the spot examined.

Form altered when removed; divisions.

The natural shape of the liver when within the body is very different from the form it assumes when removed and placed on a flat surface, unless it has been previously hardened *in situ*. As already described (pp. 304 *et seq.*) the liver has five surfaces, of which the anterior, superior and right have already been examined, while the posterior and inferior can now be fully seen. The inferior and posterior surfaces are farther subdivided into lobes by fissures which contain vessels, and marked by fossæ and impressions.

The peritoneal ligaments are described at p. 313.

Inferior surface.

The INFERIOR SURFACE (fig. 131) is rendered irregular by fissures and fossæ; and a longitudinal sulcus separates it into a large right

and a small left lobe. It embraces the liver substance as far as the upper part of the renal impression on the right side, as far as the Spigelian lobe in the middle, and it includes the whole of the left lobe except a small part to the left of the Spigelian lobe which lies upon the œsophagus.

Posterior surface.

The Posterior Surface, which is also divided into two by a con-

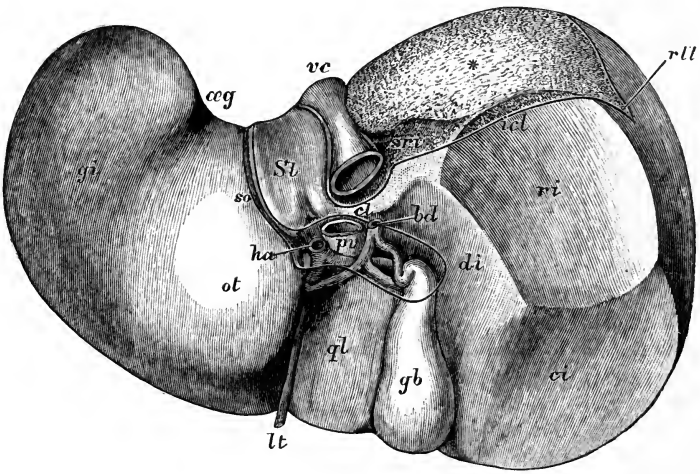


Fig. 131.—The Liver, viewed from Below and slightly from Behind (After His.)

Subdivisions and markings:

On the left lobe—

œ g. Œsophageal groove.
g i. Gastric impression.
o t. Omental tuberosity.

On the right lobe—

S l. Spigelian lobe.
c l. Caudate lobe.
q l. Quadrate lobe.
sr i. Suprarenal impression.
d i. Duodenal impression.
r i. Renal impression.
c i. Colic impression.

Vessels, &c.:

v c. Inferior vena cava.
p v. Portal vein.
h a. Hepatic artery.
b d. Common bile-duct: the last three occupy the portal fissure.
l t. Ligamentum teres, lying in the fore part of the longitudinal fissure.
g b. Gall-bladder.

Cut edges of peritoneum:

s o. The two layers of the small omentum.
i c l. The inferior layer of the coronary ligament.
r l l. Right lateral ligament.
* Surface uncovered by peritoneum.

tinuation of the longitudinal fissure, is broad over the right lobe, but narrow on the left. In the centre is a hollow for the spine, upon which the Spigelian lobe lies, to the left of this is the depression for the œsophagus, and to the right the inferior vena cava is partly embedded in the liver. On the right of the cava, the surface is rough between the layers of the coronary ligament where it was adherent to the diaphragm; and close to the vein is a small hollow

(*suprarenal impression; sr i*) into which the right suprarenal body is received.

Border. The *anterior border* is thin, and is marked by two notches; one is opposite the longitudinal fissure on the under surface before alluded to, and the other is over the large end of the gall-bladder. Anterior border.

Extremities. The right extremity is thick and rounded; and the left is thin and flattened. Extremities.

LOBES. On the inferior and posterior surfaces the liver is divided primarily into two lobes, a right and a left, by the antero-posterior or longitudinal fissure; and occupying part of the right lobe are three others, viz., the quadrate, Spigelian, and caudate lobes. Lobes are five, two large, and three small.

The *left lobe* is smaller and thinner than the right; on its posterior aspect is a groove (*œsophageal groove;* fig. 131, *œ g*) which lodges the lower end of the œsophagus, and widens out below into a hollow for the stomach (*gastric impression; g i*), occupying the greater part of the under surface of the lobe; but next to the longitudinal fissure is a considerable elevation (*omental tuberosity; o t*), which lies against the small omentum and the lesser curvature of the stomach. Left lobe impressed by œsophagus and stomach.

The *right lobe* forms the greater part of the liver, and is separated from the left by the longitudinal fissure below and behind, and by the suspensory ligament above. The under surface has a *fossa for the gall-bladder*, and is marked to the right of this by three impressions;—the one next to the gall-bladder is the *duodenal impression* (fig. 131, *d i*), and corresponds to the second part of the duodenum; more externally is the *renal impression* (*r i*) for the right kidney; and farther forwards is the *colic impression* (*c i*) where the liver rests on the transverse colon. On the posterior surface is the suprarenal impression (*sr i*) already referred to. The three following so-called lobes also are portions of the surface of the right lobe:— Right lobe presents fossa for gall-bladder impressions, for duodenum, kidney, colon, and suprarenal body,

The *quadrate lobe* (*q l*) is situate between the gall-bladder and the longitudinal fissure. It reaches anteriorly to the margin of the liver, and posteriorly to the fissure (transverse) by which the vessels enter the viscus. It is impressed by the pyloric end of the stomach and the first part of the duodenum. and three small lobes, viz., quadrate,

The *Spigelian lobe* (*S l*) is the part between the longitudinal fissure and the inferior vena cava, and belongs to the posterior surface of the liver. It forms the bottom of the hollow for the spine, from which it is separated by the diaphragm and the aorta; and it appears on the under aspect of the organ as a slight projection behind the transverse fissure. Spigelian,

The *caudate lobe* (*c l*) is a narrow, elongated eminence, which is directed from the Spigelian lobe behind the transverse fissure, so as to form the posterior boundary of that sulcus. Where the fissure terminates this projection subsides in the right lobe. and caudate.

FISSURES. Extending nearly halfway across the right part of the liver, between the Spigelian and caudate lobes on the one hand, and the quadrate lobe on the other, is the *transverse* or *portal fissure.* It is situate much nearer the back than the front, and contains the portal vein, hepatic artery, and the nerves, ducts, and lymphatics of Three fissures, viz., portal or transverse,

the liver. At the left end it is united at a right angle with the longitudinal fissure.

longitudinal

The *longitudinal fissure* extends from the front to the back of the liver, between the right and left lobes; that is, between the left lobe and the quadrate in front and the Spigelian behind. In it, anterior to the transverse fissure, lies the remnant of the umbilical vein (*l t*), which is called the round ligament, and is oftentimes arched over by a piece of the hepatic substance (pons hepatis); and behind that

(sub-divided into two parts),

fissure is a small fibrous cord, the remains of the vessel named the ductus venosus in the fœtus, which will be found running deeply in the fissure between the Spigelian and the left lobe. In reference to these structures the fore part of the longitudinal fissure is often spoken of as the *fissure for the round ligament*, and the back part as the *fissure for the ductus venosus.*

and one for vena cava.

The *groove*, or *fissure for the vena cava* is placed on the right side of the Spigelian lobe, and is frequently bridged over by an extension of the Spigelian to the right. If the cava (*v c*) be opened, two or three large and some smaller hepatic veins will be observed entering it.

The groove which lodges the gall bladder is often inappropriately called the *fissure for the gall bladder.*

Vessels in the transverse fissure.

Vessels in the Transverse Fissure. The vessels in the transverse fissure, viz., portal vein, hepatic artery and duct have the following position: the duct in anterior, the portal vein posterior, and the artery between the other two.

Hepatic duct.

The *hepatic duct* is formed by two branches,—one from the right, and one from the left lobe, which soon blend in a common tube. After a distance of one inch and a half it is joined by the duct of the gall-bladder; and the union of the two gives rise to the common bile-duct (*b d*).

Hepatic artery.

The *hepatic artery* (*h a*) is divided into two for the chief lobes, and its branches are surrounded by nerves.

Vena portæ.

The *portal vein* (*p v*) divides, like the artery, into two trunks for the right and left lobes, and gives an offset to the Spigelian lobe; its left branch is the longer.

Umbilical vein in the fœtus;

Fœtal condition of the umbilical vein. Before birth the umbilical vein occupies the longitudinal fissure, and opens posteriorly into the vena cava; the portion of the vessel behind the transverse fissure receives the name *ductus venosus.* Branches are supplied from it to both lobes of the liver; and a large one, directed to the right lobe, is joined by the portal vein. Placental or purified blood courses through the vessel at that period.

condition after birth.

Adult state. After birth the part of the umbilical vein in front of the transverse fissure is closed, and becomes eventually the *round ligament* or *ligamentum teres.* The ductus venosus is also obliterated, only a thin cord remaining in its place. But the lateral branches remain open, and subsequently form some of the divisions of the portal vein. Occasionally the ductus venosus is found pervious for some distance.

OBVIOUS STRUCTURE OF THE LIVER. The substance of the liver consists of small masses called lobules, together with vessels which are concerned both in the production of the secretion, and in the nutrition of the organ. The whole is surrounded by a fibrous and a serous coat.

Lobular structure; encased by two coats.

Serous coat. The peritoneum invests the liver almost completely, and adheres closely to the fibrous coat. At certain spots intervals exist between the two, viz., in the fissures occupied by vessels, along the line of attachment of the ligaments, and at the surface touching the gall-bladder.

Serous coat, where deficient.

The *fibrous covering* is very thin, but it is rather stronger where the peritoneum is not in contact with it. It invests the liver, and is continuous at the transverse fissure with the fibrous sheath (capsule of Glisson) surrounding the vessels in the interior. When the membrane is torn from the surface, it will be found connected with fine shreds entering into the liver.

Fibrous covering is prolonged into the interior.

Size and form of the lobules. The lobules (fig. 132, *l*) constitute the proper secreting substance, and can be seen either on the exterior of the liver, on a cut surface, or by means of a rent in the mass. As thus observed, these bodies are about the size of a pin's head, and measure from $\frac{1}{20}$th to $\frac{1}{10}$th of an inch in diameter. Closely massed together, they possess a dark central point; and there are indications of lines of separation between them, though they are to some extent united together. By means of transverse and vertical sections of the lobules, their form appears flattened on the exterior, but they are many-sided in the interior of the liver. They are clustered around the smallest divisions of the hepatic vein, to which each is connected by a small twig issuing from the centre, something like the union of the stalk with the body of a small fruit.

Lobules of the liver: size and appearance; form; position to veins.

VESSELS OF THE LIVER. Two sets of blood-vessels ramify in the liver:—One enters the transverse fissure, and the branches are directed transversely in spaces (portal canals) where they are enveloped by areolar tissue. The other set (hepatic veins) runs from the anterior to the posterior border of the liver for the most part without a sheath. The ramifications of these different vessels are to be followed in the liver.

Vessels in the liver.

The *capsule of Glisson* is a layer of areolar tissue, which envelops the vessels and the ducts in the transverse fissure, and is continued on their branches in the portal canals. In this sheath the vessels ramify, and become minutely divided before their termination in the lobules. If a transverse section is made of a portal canal, the vessels will retract somewhat into the loose surrounding tissue.

Capsule of Glisson.

The *portal vein* ramifies in the liver like an artery; and the blood circulates through it in the same manner, viz., from trunk to branches. After entering the transverse fissure the vein divides into large branches; these lie in the portal canals or spaces, with offsets of the hepatic artery, the hepatic duct, and the nerves and lymphatics (fig. 132, P). The division is repeated again and again

Portal vein occupies portal canals,

and supplies branches;

until the last branches of the vein (*interlobular*) penetrate between the lobules, where they communicate together, and supply the hepatic substance.

receives vaginal branches.

In the portal canals the offsets of the vena portæ are joined by small *vaginal* and *capsular veins*, which convey blood from branches of the hepatic artery.

Hepatic artery nourishes the vessels and capsule:

The *hepatic artery* (fig. 132, *c*), while surrounded by the capsule, furnishes *vaginal branches*, which ramify in the sheath, giving it a red appearance in a well-injected liver, and supply twigs to the coats of the portal vein and biliary ducts, and to the areolar tissue: from the vaginal branches a few offsets (*capsular*) are given to the coat of the liver. Finally, the artery ends in fine *interlobular branches*, from which offsets enter the lobules.

ending in lobules.

Hepatic veins without a sheath, begin in the lobules,

The *hepatic veins* (venæ cavæ hepaticæ) begin by small *intralobular veins* from the centre of the lobules; these are received into the *sublobular branches*, which anastomose together, and unite into larger vessels. Finally, uniting with neighbouring branches to produce larger trunks, the hepatic veins are directed from before backwards to the vena cava inferior, into which they open by large orifices. The hepatic veins may be said to be without a sheath, except in the larger trunks; so that when they are cut across the ends remain patent, in consequence of their close connection with the liver structure.

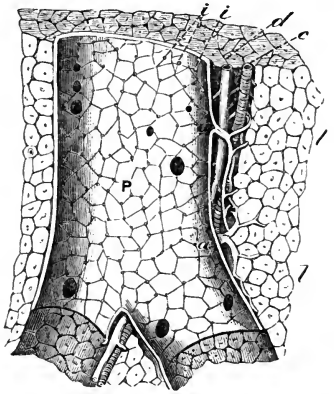


Fig. 132.—Vessels in a Portal Canal, and the Lobules of the Liver (Kiernan).

l. Lobules of the liver.

P. Branch of the portal vein, with *a*, *a*, small branches which supply interlobular offsets.

c. Hepatic artery.

d. Hepatic duct.

i, *i*. Openings of interlobular branches of the portal vein.

and end in the vena cava.

Biliary ducts form

Hepatic duct. The biliary ducts follow the portal vein in their mode of branching, and run with the other vessels in the portal canals (fig. 132, *d*). They issue from the liver at the transverse fissure in right and left trunks, which by their union form the common hepatic duct.*

right, left, and common hepatic ducts.

Structure of medium-sized ducts.

Structure. The moderately-sized hepatic ducts consist of a fibrous coat, lined by a mucous layer; and penetrating the wall is a longitudinal row of openings, on each side, leading into sacs, and into branched tubes which sometimes communicate.

* Aberrant ducts exist between the pieces of the peritoneum in the left lateral ligament of the liver, and in the bands bridging over the round ligament and vena cava; they anastomose together, and are accompanied by branches of the vessels of the liver, viz., portal vein, hepatic artery, and hepatic vein.

Lymphatics of the liver are superficial and deep. The superficial of the upper surface in part join the lymphatics of the thorax by piercing the diaphragm, and enter the anterior mediastinal glands; those of the under surface mainly join the deep lymphatics issuing at the portal fissure. Lymphatics: superficial,

The deep lymphatics accompany both sets of vessels in the liver; those with the portal vein descend through some small glands in the lesser omentum and end in the cœliac glands; while those accompanying the hepatic veins pass through the diaphragm, and enter the glands of the posterior mediastinum. and deep.

Nerves come from the sympathetic and the pneumo-gastric, and ramify with the hepatic artery. Nerves.

THE GALL-BLADDER.

The gall bladder (fig. 131, *g b*, p. 346) is the receptacle of the bile. It is situate in a depression on the under surface of the right lobe of the liver, and to the right of the quadrate lobe. It is pear-shaped, and its larger end (*fundus*) is directed forwards beyond the margin of the liver; while the smaller end (*neck*) is turned in the opposite direction, and bends downwards to terminate in the cystic duct by a zigzag part. Gall Bladder: situation; form;

In length the gall-bladder measures three or four inches, and in breadth rather more than an inch at the widest part. It holds from an ounce to an ounce and a half. size;

By one surface it is in contact with the liver, and on the opposite it is covered by peritoneum. The larger end touches the abdominal wall opposite the cartilage of the ninth rib (fig. 111, p. 303), where it is contiguous to the transverse colon. The neck is in contact with the duodenum. relations.

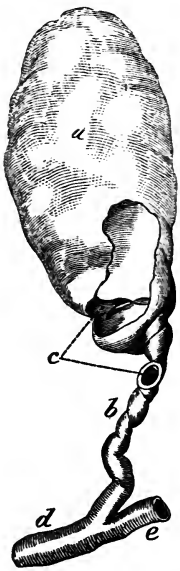


FIG. 133.—GALL-BLADDER AND ITS DUCT.

a. Gall-bladder.
b. Cystic duct.
c. Ridges in the interior.
d. Common bile-duct.
e. Common hepatic duct.

Structure. The gall-bladder possesses a peritoneal, a fibrous and muscular, and a mucous coat. Structure of wall.

The *serous coat* is stretched over the under or free surface of the gall-bladder, and surrounds the fundus. Serous coat.

The *fibrous coat* is strong, and forms the framework of the sac; intermixed with it are some involuntary *muscular fibres*, the chief being longitudinal, but others circular. Fibrous and muscular stratum.

Dissection. The gall-bladder should now be slit open and washed out to show its lining.

The *mucous coat* is marked internally by numerous ridges and intervening depressions, which give an alveolar or honeycomb Mucous layer is alveolar on surface;

appearance to the surface. This condition will be seen, with the aid of a lens, to be most developed about the centre of the sac, and to diminish towards each extremity. In the bottom of the larger pits are depressions leading to recesses.

projections of the wall.

Where the gall-bladder ends in the cystic duct (fig. 133) its coats project into the interior, and give rise to ridges resembling those in the sacculated large intestine.

Duct of gall-bladder;

The *cystic duct* (*b*) joins the hepatic duct at an acute angle, to form the common bile-duct. It is about an inch and a half long, and is distended and somewhat sacculated near the gall-bladder.

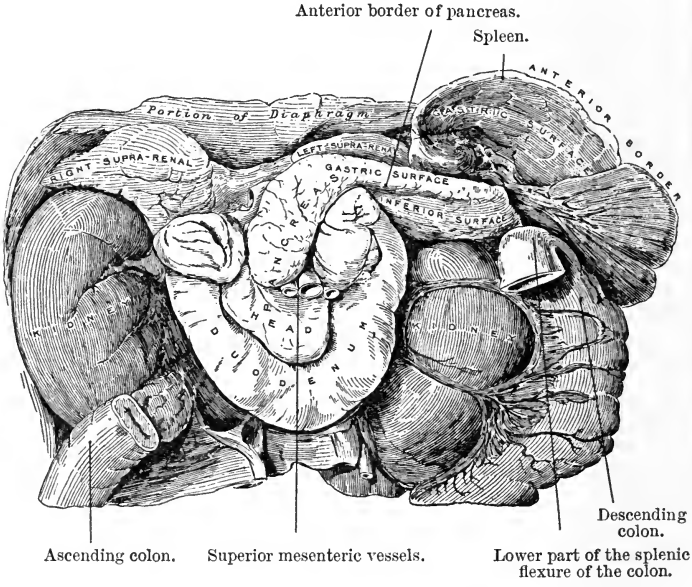


FIG. 134.—DEEP VISCERA OF THE ABDOMEN OF A CHILD.
(From a specimen in the Charing Cross Hospital Museum.)

structure.

Structure. The coats of the duct are formed like those of the sac from which it leads, but the muscular fibres are very few. The mucous lining is provided with glands, as in the hepatic and common bile-ducts.

Mucous coat like a screw.

On opening the duct the mucous membrane may be observed to form about twelve semi-lunar projections (fig. 133, *c*), which are arranged obliquely around the tube, and increase in size towards the gall-bladder. This structure is best seen on a gall-bladder which has been inflated and dried, as in this state the parts of the duct between the ridges are most stretched.

Artery and vein:

Blood-vessels and nerves. The vessels of the gall-bladder are named *cystic*. The artery is a branch of the hepatic; and the cystic vein

nerves and

opens into the right branch of the vena portæ. The *nerves* are

derived from the hepatic plexus, and entwine around the vessels. The *lymphatics* follow the cystic duct, and join the lymphatics on the under surface of the liver. Lymphatics.

THE KIDNEYS AND THE URETERS.

Dissection. The student will now return to the abdomen, and thoroughly clean up the kidneys and the suprarenal bodies and their vessels, removing the fat and enveloping areolar tissue, which is particularly strong at the upper part of each kidney where it passes on to the diaphragm. Care should be taken not to injure the suprarenal bodies, which somewhat resemble the fat. After the anterior surface of the left kidney has been examined, its vessels will be cut through about an inch from the hilum, and the kidney, with the upper four inches of the ureter, removed for separate examination. The parts behind the kidney will then be cleaned, taking care of the anterior divisions of the last dorsal and first lumbar nerves as they cross outwards over the quadratus lumborum muscle.

The KIDNEYS have a characteristic form (fig. 134 and fig. 135, p. 354), resembling an oval with one side (the inner) somewhat hollowed out, and they are compressed from before backwards. Kidney: form;

With the special form above mentioned, each kidney is of a deep red colour, and has an even surface. Its average length is about four inches; its breadth two and a half inches; and its thickness rather more than one inch; but the left is commonly longer and more slender than the right kidney. Its usual weight is about four ounces and a half in the male, and rather less in the female. The left kidney is slightly heavier than the right. Colour; size; and weight.

The *upper* extremity or *pole*, of the kidney is broader than the lower, and is in contact with a suprarenal body. The *lower pole* is more pointed. Extremities;

The outer border is convex; but the inner is excavated, and is marked by a longitudinal fissure—the *hilum*. In the fissure the vessels are usually placed so that the divisions of the renal vein are in front, the ureter behind, and the branches of the artery between the two. On the vessels, the nerves and lymphatics ramify; and areolar tissue and fat surround the whole. The fissure leads into a hollow named the *sinus*, in which the vessels and the duct are contained before they pierce the renal substance. borders. Contents of the fissure: their position. Sinus.

For the purpose of distinguishing between the right and the left kidneys, let the excavated margin be turned inwards, with the ureter or excretory tube behind the other vessels; and let that end of the viscus be directed downwards, towards which the ureter is naturally inclined. To distinguish right from left.

The *surface marking* of the kidneys has been described on p. 306.

They lie opposite the last dorsal and the upper two or three lumbar vertebræ; the right kidney being somewhat lower than the left. Both overlie the twelfth rib in their upper part; the upper pole of the right kidney reaches above that rib and the upper pole of the left commonly overlies the eleventh rib. Position.

Surfaces.

Their anterior surfaces look somewhat outwards, and are more convex than the posterior, which, latter, look partly inwards and are moulded on the posterior abdominal wall.

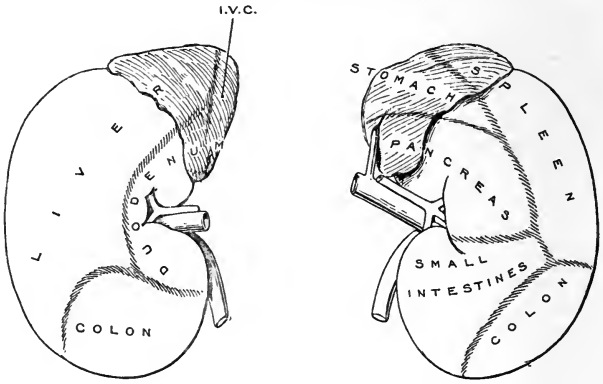
Anterior

In well-preserved specimens the anterior surfaces are distinctly facetted by the pressure of the overlying viscera; the distinctness of the ridges indicating the extent of the moulding that the kidney has undergone.

The position of the overlying parts has already been studied, and the extent of the contact with the subjacent kidneys is diagrammatically shown in the accompanying figure (135).

of right kidney,

A large part of the ANTERIOR SURFACE of *the right kidney* is in contact with the liver, and its limit below and internally is usually defined by a well-marked ridge. The whole of this surface is covered by peritoneum except at the upper and inner angle, where the suprarenal body overlaps the kidney. The lower end of the kidney usually presents a well-defined surface looking downwards



RIGHT KIDNEY. LEFT KIDNEY.

FIG. 135.—DIAGRAM OF THE RELATIONS OF THE ANTERIOR AND OUTER ASPECTS OF THE KIDNEYS.

I.V.C. marks the surface in contact with the vena cava.

and forwards, where it is impressed by the ascending colon. The duodenum lies, to a variable extent, over the inner part.

of left kidney.

The spleen above and the descending colon below usually give rise to distinct impressions on the outer margin of *the left kidney;* the suprarenal body, along the inner border above, reaches down as far as the hilum ; the pancreas extends across in front of the hilum as far as the splenic impression, and a small part of the anterior surface of the kidney above this is usually in contact with the stomach. The lower half of the anterior surface below the pancreas presents a large surface, upon which lie coils of the jejunum.

Posterior surfaces.

The POSTERIOR SURFACE of each kidney presents an inner area, where it lies against the psoas muscle and the crus of the diaphragm as these parts clothe the sides of the bodies of the vertebræ, and an

outer area which looks backwards and overlies the twelfth rib and the diaphragm for about its upper third, and below this the quadratus lumborum. Crossing outwards and downwards behind this part of the kidney the anterior divisions of the last dorsal and first lumbar nerves will be seen upon the quadratus lumborum (fig. 138, p. 363). When the kidney has been hardened *in situ*, particularly in thin subjects, an indentation produced by the first two lumbar transverse processes may be present near the hilum.

Dissection. The left kidney should now be cut through from the inner to the outer border, and to remove the loose tissue from the vessels and the divisions of the excretory duct. The sinus containing the blood-vessels now comes completely into view.

Open the kidney, and clean the vessels.

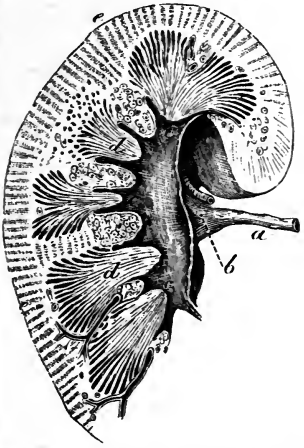


Fig. 136.—Section through a Piece of the Kidney, showing the Medullary and Cortical Portions and the Beginning of the Ureter.

a. Ureter.
b. Pelvis.
c. Calyx.
d. Pyramids.
e. Cortical portion of the kidney.

The *interior of the kidney* (fig. 136) is seen on section to consist of an external granular or cortical portion, and of an internal part made of darker coloured pyramidal masses converging towards the centre.

Renal substance divided into cortical and pyramidal.

The *pyramidal masses* (pyramids of Malpighi ; *d*) are from eight to eighteen in number, but generally more than twelve. The apex of each mass which is free from cortical covering, is directed to the sinus, and ends in a smooth, rounded part, named *mamilla* or *papilla*. In it are the openings of the urine tubes, which are about twenty in number in each papilla, some being situate in a central depression, and others on the surface ; and it is surrounded by one of the divisions (calyx, *c*.) of the excretory tube. Occasionally two of the masses are united in one papillary termination. The base is embedded in the cortical substance, and from it slender processes are continued into the cortical covering. The cut surface of the pyramid has a striated appearance, owing to the arrangement of the uriniferous tubules composing it, and the blood-vessels. If the mass is compressed in a fresh kidney, urine will exude from the tubes through the apertures in the apex.

Pyramids : number ; apex ; ends in papilla ; Structure ; base.

The *cortical part* (fig. 136, *e*) forms about three-fourths of the kidney ; it covers the pyramidal masses with a layer nearly a quarter of an inch in thickness, and sends prolongations between them nearly to their apices. Its colour is of a light red, unless the kidney is blanched ; and its consistence is so slight that the mass gives way

Extent of cortical substance : colour ; consistence.

beneath the pressure of the finger. In the injected kidney red points (Malpighian bodies) are scattered through the cortex, giving it a granular appearance.

Fibrous coat

The kidney has a *fibrous tunic* or *capsule*, which is connected to the glandular substance by fine processes and vessels, and is readily detached from it by slight force. At the inner margin of the

sends in offsets.

kidney it sinks into the sinus, where it sends processes on the entering vessels, and becomes continuous with the outer coat of the excretory duct.

Blood-vessels.

BLOOD-VESSELS. The artery and vein distributed to the kidney are very large in proportion to the size of the organ they supply.

Branching of the renal artery.

Renal artery. Before reaching the kidney the renal artery divides into four or five pieces; and these in the sinus break up into smaller branches, which enter the organ between the papillæ. They run in the processes of cortical substance that separate the pyramids, being surrounded by sheaths from the fibrous capsule, and undergoing farther subdivision, until they reach the bases of the pyramids. Here the branches form arches, from which the minute offsets to the secreting structures are given off. Some twigs are supplied to the capsule of the kidney; and these anastomose with the subperitoneal branches of the lumbar arteries.

Vein agrees with artery.

Renal vein. The larger branches of the vein spring from arches like those of the artery, and take a similar course through the cortical septa to the sinus. In the neighbourhood of the hilum all are commonly united into one trunk, which joins the inferior cava.

Nerves.

Nerves. The ramifications of the sympathetic nerve may be traced to the smaller branches of the artery.

Lymphatics.

The *absorbents* are superficial and deep. Both unite at the hilum of the kidney, and join the lumbar glands.

Ureter:

The URETER is the tube by which the fluid excreted in the kidney

office;

is conveyed to the bladder. Between its origin and termination

length;

the canal measures from fourteen to sixteen inches in length. Its

size varies;

size corresponds commonly with that of a large quill. Near the kidney it is dilated into a funnel-shaped part, named *pelvis;* and near the bladder it is again somewhat enlarged, though the lower aperture by which it terminates is the narrowest part of the tube; but this part of it will be studied later.

course

In its course from the kidney to the bladder the ureter is close beneath the peritoneum, and is directed obliquely downwards and inwards along the posterior wall of the abdomen to the pelvis. At

and relations.

first the ureter is placed over the psoas, inclining on the right side towards the inferior vena cava; and about the middle of the muscle it is crossed by the spermatic vessels. Lower down it lies over the common or external iliac artery, being beneath the pelvic colon on the left side, and the end of the ileum on the right side. Lastly, it inclines forwards below the level of the obliterated hypogastric artery to reach the base of the bladder.

Occasionally double.

Sometimes the ureter is divided into two for a certain distance.

Part in the kidney (fig. 136, *b*). Near the kidney the ureter is dilated into a funnel-shaped part called the *pelvis*. It begins in the sinus of the kidney by a set of cup-shaped tubes, named *calices* or *infundibula* (*c*), which vary in number from seven to thirteen. Each cup-shaped process embraces the rounded end of a pyramidal mass, and receives the urine from the apertures in that projection : sometimes a calyx surrounds two or more papillæ. The several calices are united together to form two or three larger tubes ; and these are finally blended in the pelvis.

Ureter dilated near the kidney ; has calices, which embrace papillæ.

Structure. The chief part of the wall of the ureter is composed of a *muscular coat*, in which there is an outer layer of circular, and an inner layer of longitudinal fibres. This has an external investment of fibrous tissue, and is lined by *mucous membrane*.

Three coats to ureter: fibrous, muscular, and mucous.

The *calices* resembles the rest of the duct in having a fibrous, a muscular, and a mucous coat. Around the base of the papilla the outer coat of the calyx is continuous with the enveloping tunic of the kidney ; and at the apex the mucous lining is prolonged into the uriniferous tubes through the small openings.

The calices also three coats.

Vessels. The *arteries* are numerous but small, and are furnished by the renal, spermatic, internal iliac, and inferior vesical. The *veins* correspond with the arteries.

Vessels.

The *lymphatics* are received into those of the kidneys.

Lymphatics.

THE SUPRARENAL BODIES.

These small bodies (figs. 134 and 135) have received their name from their position in regard to the kidney. Their vessels and nerves are numerous, but they are not provided with any excretory duct.

Suprarenal capsule : no duct.

One body is situate on the upper end of each kidney, with an inclination to the inner side, and, without care, may be removed with the surrounding fat, which it resembles. Its colour is a brownish-yellow. Both bodies are rather triangular in shape, and flattened, but with the upper angle rounded off, and the base or lower part hollowed where they touch the kidney. The *right* suprarenal is more definitely triangular than the left, and is often spoken of as cocked-hat shaped, while the *left* is larger from above downwards, and is somewhat pyramidal. They are each somewhat flattened, and their two surfaces look outwards and forwards, and backwards and inwards respectively. On the anterior surface of each is a fissure, termed the *hilum*, where the vein issues.

Situation ; colour ; and form.

Hilum.

In the adult they measure about one inch an a half in depth, and rather less in width ; and the weight of each is between one and two drachms, but the left is commonly larger than the right

Size and weight.

Areolar tissue attaches the suprarenal body to the kidney ; and the vessels and nerves retain it in place. The relations to surrounding parts are much the same as those of the upper end of the kidney. Thus each rests on the diaphragm, as it clothes the vertebræ on both sides ; while in front of the right suprarenal is the liver externally, and the inferior vena cava internally ; and in front of the left the pancreas, stomach and spleen, from below upwards. On the inner side of the

Relations.

right capsule, beside the vena cava is the solar plexus; and internal to the left are the aorta, with the cœliac axis, and the solar plexus.

Consists of two parts,

Obvious structure. A vertical section of a fresh suprarenal body shows it to be formed of an external or cortical layer, and an internal or medullary substance. The whole is surrounded by a thin fibrous capsule, which sends processes into the interior, and along the blood-vessels.

with a fibrous capsule.

Cortical and

The *cortical part* is of a deep yellow colour, and firm. It forms about two-thirds of the thickness of the whole body, and in the section appears striated perpendicularly to the free surface of the organ. The *medullary part* is dark brown or nearly black, and very soft and pulpy. If the specimen is not fresh, it may look as if the cortical part enclosed a cavity.

medullary parts.

Arteries.

Blood-vessels. Numerous *arteries* are furnished to the suprarenal bodies. Generally there are three vessels, one directly from the aorta, and one each from the diaphragmatic and renal arteries. Their small branches penetrate the organ at many spots of its circumference.

Veins.

The *veins* are for the most part collected into one long trunk, which issues by the hilum, and opens on the right side into the vena cava, on the left into the renal vein. Other smaller veins pass out through the cortex to the renal vein and the vena cava.

Nerves.

Nerves. The nerves are very numerous and large, and come from the solar plexus.

Lymphatics.

Lymphatics are superficial and deep; both join those of the kidney.

THE DIAPHRAGM WITH AORTA AND VENA CAVA.

To see the diaphragm.

Dissection. The student will now clean, first the diaphragm, then the large vessels and their branches, and afterwards the deep muscles of the abdomen. For the dissection of the diaphragm it will be necessary to remove the peritoneum, defining especially the central tendinous part, and the strong processes or pillars which are fixed to the lumbar vertebræ. While cleaning the muscle the student should be careful of the vessels and nerves on its surface, and of others in and near the pillars. The right kidney and suprarenal will be drawn downwards or thrown over to the left in cleaning the diaphragm, but their vessels should be preserved.

Define arches.

On the right side two aponeurotic bands or arches near the spine, which give attachment to the muscular fibres, should be dissected; one curves over the internal muscle (psoas); the other extends over the external muscle (quadratus lumborum), and will be made more evident by separating it from the fascia covering the muscle.

Diaphragm: situation and form;

The DIAPHRAGM or midriff (fig. 137, A p. 360) forms the vaulted movable partition between the thorax and the abdomen. It is fleshy externally, where it is attached to the surrounding ribs and the spinal column, and tendinous in the centre.

origin at the circumference;

The *origin* of the muscle is at the circumference, and is alike on both sides. Thus, it arises on each side by fleshy slips from the inner surface of the ensiform process and the six lower rib cartilages; from

two aponeurotic arches between the last rib and the spinal column,—one being placed over the quadratus lumborum, and the other over the psoas muscle; and, lastly, from the lumbar vertebræ by a thick muscular piece or pillar. From this extensive origin the fibres are directed inwards, with different degrees of obliquity and length, to the central tendon; but some have a peculiar disposition in the pillars which will be afterwards noted. insertion of fibres into a central tendon.

The abdominal surface is concave, and is covered for the most part by the peritoneum. In contact with it on the right side are the liver, kidney and supra renal; and on the opposite side, the stomach, spleen, kidney and supra renal; in contact also with the pillars are the pancreas and the solar plexus with the semilunar ganglia. Parts in contact with the under surface,

The thoracic surface is covered by the pleura of each side and the pericardium. At the circumference the fleshy processes of origin alternate with like parts of the transversalis muscle; but a slight interval separates the slip arising from the ensiform process from that attached to the seventh cartilage, and a second space comes between the fibres from the last rib and the arch over the quadratus lumborum muscle. and with the upper Attachment of border. Intervals in the muscle.

These apertures mark the situation between the three parts of which the diaphragm is essentially formed, viz., *sternal*, from the ensiform cartilage, *costal*, from the costal cartilages, and *vertebral*, from the vertebræ and the tendinous arch over the psoas muscle. The interval between the vertebral and costal parts near the last rib is occasionally large, and through it a communication between the abdominal and thoracic cavities may take place and abdominal viscera be found in the thorax. Apertures.

Structure. The muscle is convex towards the chest, and concave to the abdomen. Its vault reaches higher on the right than the left side, and is constantly varying during life in respiration. In the condition of rest, as met with after death (state of expiration), the central portion is about opposite the xiphi-sternal articulation; on the right side it rises to the level of the fifth, and on the left side to the sixth chondro-sternal articulation. Vault: extent upwards.

Special parts of the diaphragm. The following named parts are now to be noticed more fully, viz., the central tendon, the pillars, the arches, and the apertures. Special parts to be examined.

The *central tendon* (cordiform tendon) occupies the middle of the diaphragm (fig. 137), and is surrounded by muscular fibres: the large vena cava pierces it. It is of a pearly white colour, and its tendinous fibres cross in different directions. In form it is compared to a trefoil leaf; of its three lobes or segments the right (*c*) is the largest, and the left (*a*) the smallest. Central tendon, like a trefoil leaf.

The *pillars* (crura) are two large muscular and tendinous processes (*d* and *e*), one on each side of the abdominal aorta. They are narrow and tendinous below, where they are attached to the upper lumbar vertebræ, but large and fleshy above; and between them is a tendinous arch over the aorta. Two pillars, with arch over aorta:

In each pillar the fleshy fibres pass upwards and forwards, diverging from each other; the greater number join the central tendon without arrangement of fibres in each

as they ascend to tendon;

intermixing, but the inner fibres of the two crura cross one another in the following manner:—Those of the right (*e*) ascend by the side of the aorta, and pass to the left of the middle line, decussating with the fibres of the opposite crus between that vessel and the opening of the œsophagus. The fibres of the other crus (*d*) may be traced in the same way, to form the right half of the œsophageal opening. In the decussation the fasciculus of fibres from the right crus is generally larger than, and in front of, that from the left.

differences in the pillars.

The pillars differ somewhat on opposite sides. The right (*e*) is the larger of the two, and is fixed by tendinous processes to the bodies of the first three lumbar vertebræ, and their intervertebral substances, reaching down to the disc between the third and fourth vertebræ. The left pillar (*d*) is situate more on the side of the spine,

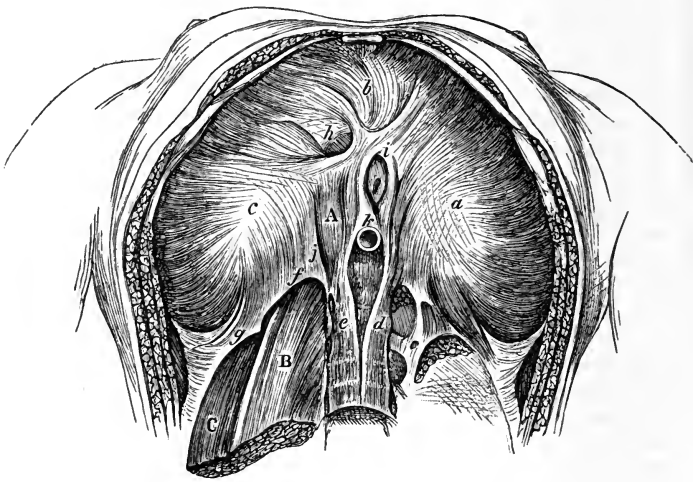


FIG. 137.—UNDER SURFACE OF THE DIAPHRAGM.

A. Diaphragm.
B. Psoas magnus.
C. Quadratus lumborum.
a. Left piece of the tendon of the diaphragm.
b. Middle, and *c*, right piece.
d. Left, and *e*. right crus.
f. Inner, and *g*, outer arched ligament.
h. Opening for vena cava, *i*, for œsophagus, *k*, for aorta, *j*, for splanchnic nerves.

is partly concealed by the aorta, and does not reach so far as the right by the depth of a vertebra, and it is even occasionally wanting.

Two arched ligaments,

The *arches* (ligamenta arcuata) are two fibrous bands on each side over the quadratus lumborum and psoas muscles, which give origin to fleshy fibres.

internal

The arch over the psoas (*lig. arcuat. internum; f*) is the stronger, and is connected by the one end to the tendinous part of the pillar of the diaphragm, and by the other to the transverse process of the first or second lumbar vertebra.

and external.

The arch over the quadratus lumborum (*lig. arcuat. externum; g*)

is only a thickened piece of the fascia covering that muscle, and extends from the first lumbar transverse process to the last rib.

Apertures. There are three large openings; one each for the aorta, the vena cava, and the œsophagus; with some smaller fissures for nerves and vessels. Apertures are :—

The opening for the aorta (*k*) is rather behind than in the diaphragm, for it is situate between the pillars of the muscle and the spinal column : it transmits the aorta, the thoracic duct, and the large azygos vein. For the aorta; its contents.

The opening for the œsophagus and the pneumo-gastric nerves (*i*) is above and slightly to the left of the aortic aperture : it is placed in the muscular part of the diaphragm, and is bounded by the fibres of the pillars as above explained. For gullet and nerves.

The opening for the vena cava (foramen quadratum ; *h*) is situate between the middle and right divisions of the central tendon ; and its margins are attached to the vein by tendinous fibres. For the vena cava.

There is a *fissure* (*j*) in each pillar for the three splanchnic nerves ; and through that in the left crus the small azygos vein also passes. Fissures in the pillars.

Action of the diaphragm. By the contraction of the muscular fibres in inspiration the tendon, particularly its lateral parts, is moved downwards, and the arch of the diaphragm lessened. During relaxation in expiration, the centre of the muscle is elevated, and the height of the vault increased owing to the elasticity of the lungs, and the pressure of the viscera below, which are forced upwards by the action of the abdominal muscles. In forced expiration the muscle reaches as high as the fourth rib on the right side, and the fifth on the left, close to the sternum. Use in respiration. Height in forced expiration.

In the descent of the diaphragm, the parts of the tendon move unequally, in consequence of differences in their relations, and in the length and direction of the fleshy fibres connected with them. Thus, the central lobe, above which the heart is placed, moves least; while the lateral lobes, which are below the lungs descend more freely. It is estimated that the central lobe of the tendon moves downwards in full inspiration about two-fifths of an inch, the right lobe twice as much, and the left lobe one inch. (Hasse). Central part moves least; left part most. Average descent in full inspiration.

Keith is of opinion that an important part of the action of the crura, the fibres of which pass into the central part of the tendon, is to render tense, and depress the attached fibrous pericardium, and to exercise a pull upon the aorta of the lungs, which are held to the upper surface of the tendon of the diaphragm by the broad ligament of the lung.

With the movement of the diaphragm the size of the cavities of the abdomen and thorax are altered. By its descent the thorax is enlarged and the abdomen diminished ; and the viscera in the upper part of the latter cavity, viz., liver, stomach and spleen, are partly moved from beneath the ribs. By its ascent the cavity of the thorax is lessened, and that of the abdomen is restored to its former size ; and the displaced viscera return to their usual place. By the contraction of the fibres the aperture for the œsophagus will Effect on thorax and abdomen, on viscera, and on apertures.

be rendered smaller, and that tube compressed; but the other openings for the vena cava and aorta, having tendinous surroundings, are not materially changed. The possible sphincter action of the fibres around the œsophageal opening is most likely to secure closure of that part against the gastric contents when the descending diaphragm, in its contraction, presses upon the stomach.

Action involuntary.

The action of the diaphragm is commonly involuntary, but it is perfectly under the control of the will.

Take away greater part of the diaphragm.

Dissection. After the diaphragm has been learnt the ribs that support it on each side may be cut through if the thorax has been sufficiently dissected, and the loose pieces of bone with the fore part of the diaphragm may be taken away, to facilitate the dissection of the deeper vessels and muscles. But the posterior third of the diaphragm, with its pillars and arches, should be left; and the vessels ramifying on it should be followed back to their origin.

Clean aorta, vena cava, and branches;

The large vessels of the abdomen, viz., the aorta and the vena cava, are to be cleaned by removing the fat, the remains of the sympathetic plexuses, and the lymphatic glands; and their branches are to be followed to the diaphragm, to the right kidney and supra-renal body, and to the ovary, or to the inguinal canal for the testicle, as the case may be. In like manner the large iliac branches of the aorta and cava are to be laid bare as far as Poupart's ligament. The ureter and the spermatic vessels are to be cleaned as they cross the iliac artery; and on the same vessel, near the thigh, branches of a small nerve (genito-crural) are to be sought.

also iliac vessels.

Dissect muscles;

The muscles are to be laid bare on the left side, but on the right side the fascia covering them is to be shown.

psoas and nerves of lumbar plexus,

The *psoas* muscle, the most internal, lies on the side of the spine, with the small psoas (if present) superficial to it. On its surface, and in the fat external to it, the following branches of the *lumbar plexus* will be found:—The genito-crural nerve lies on the front. Four nerves issue at the outer border,—the ilio-hypogastric and ilio-inguinal near the top, the external cutaneous about the centre, and the large anterior crural at the lower part (fig. 138 and fig. 140, p. 373). Along the inner border of the psoas the gangliated cord of the *sympathetic* is to be sought, with a chain of lumbar lymphatic glands; and lower down the obturator nerve may be recognised entering the cavity of the pelvis. External to the psoas is the *quadratus lumborum*, and crossing the latter near the last rib is the last dorsal nerve, with an artery. In the hollow of the hip-bone is the iliacus muscle, which unites below with the large psoas.

quadratus lumborum,

and iliacus.

Extent of abdominal aorta.

The ABDOMINAL AORTA (fig. 138, (*b*) extends from the lower part of the last dorsal vertebra to about the middle of the body of the fourth lumbar vertebra, where it divides into the common iliac arteries. Its commencement is between the pillars of the diaphragm; and its termination is placed opposite a spot below and slightly to the left of the umbilicus, and nearly on a level with the highest point of the iliac crest.

surface marking.

Relations

The chief relations of the vessel to surrounding parts have been

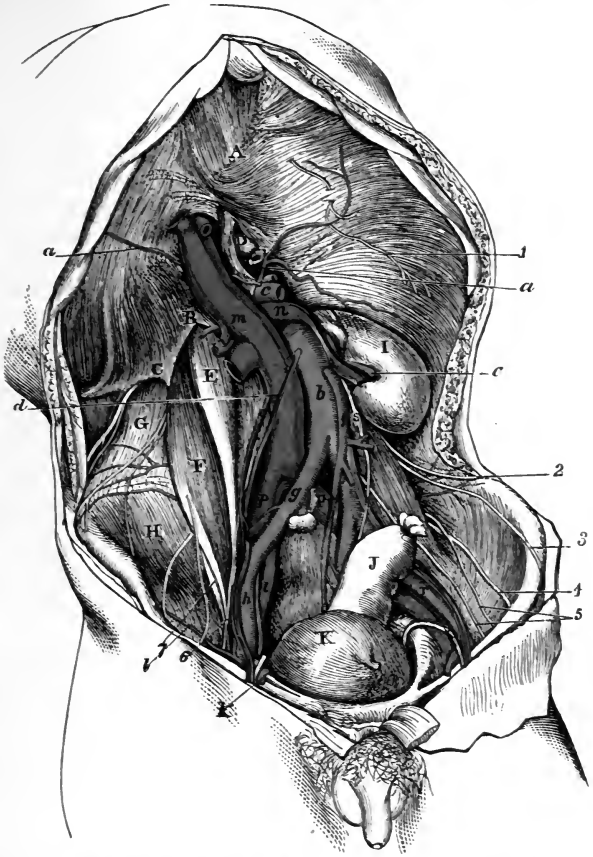


FIG. 138.—DEEP VIEW OF THE MUSCLES, VESSELS, AND NERVES OF THE ABDOMINAL CAVITY (ILLUSTRATIONS OF DISSECTIONS).

Muscles and viscera :

A. Diaphragm, with B, internal, and C, external arched ligament.
D. End of the œsophagus, cut.
E. Small psoas.
F. Large psoas.
G. Quadratus lumborum.
H. Iliacus.
I. Kidney.
J. Rectum.
K. Bladder.

Vessels :

a. Diaphragmatic artery.
b. Aorta.
c. Renal.
d. Spermatic.
e. Upper mesenteric, cut.
f. Lower mesenteric.
g. Common iliac, and *h*, external iliac artery.
k. Deep epigastric artery, cut ; by its side is the vas deferens, bending into the pelvis.
l. Deep circumflex iliac.
m. Vena cava.
n. Renal vein.
o, Right spermatic vein.
p. Common iliac vein, and *r*, external iliac (this letter is put on the left *artery* instead of on the *vein* just below it).
s. Ureter.

Nerves :

1. Phrenic.
2. Ilio-hypogastric.
3. Ilio-inguinal.
4. External cutaneous of the thigh.
5 and 6. Genito-crural.
7. Anterior crural.

with deep vessels.

before referred to (p. 320), but some deep vessels in connection with it now come into view. As the aorta rests on the spine it lies on the left lumbar veins, which end in the inferior cava. And between it and the right crus of the diaphragm are the large azygos vein and the thoracic duct. Along the sides of the vessel are the lumbar lymphatic glands, from which large vessels run beneath it to end in the beginning of the thoracic duct.

Place of origin of the branches;

The BRANCHES of the aorta are numerous, and arise in the following order :—First, are the diaphragmatic arteries, two in number, which leave the front of the vessel immediately it appears in the abdomen. Close to the tendinous ring of the diaphragm, the single trunk of the cœliac axis arises from the front; and about a quarter of an inch lower down, also on the front, the trunk of the superior mesenteric artery begins. Half an inch lower, the renal arteries, right and left, take origin from the sides of the aorta. On the lateral part of the vessel, close above each renal, is the small suprarenal branch; and below the renal is the slender spermatic artery. From the front of the trunk, one or two inches above the bifurcation, springs the inferior mesenteric artery. And from the back of the vessel arise five lumbar arteries on each side, and the middle sacral close above the bifurcation.

their classification.

The branches may be classified in two sets,—one to the viscera of the abdomen (visceral), and another to the abdominal wall (parietal).

Some visceral branches.

The *visceral branches* are cœliac axis, superior and inferior mesenteric, renal, capsular. and spermatic. Of these, the first three have already been examined.

Renal artery

The *renal arteries* (fig. 138, *c*) leave the aorta nearly at a right angle, and are directed outwards, one on each side. Near the kidney each divides into four or five branches, which enter the hilum of

is beneath its vein;

the organ between the vein and the ureter. Each artery lies beneath its companion vein, being surrounded by a plexus of nerves,

gives offsets;

and supplies small twigs to the suprarenal body (*inferior capsular*), to the ureter, and to the fatty layer about the kidney.

difference between left and right.

The arteries of opposite sides have some differences. The left is the shorter, owing to the position of the aorta : the right crosses the spine, and passes beneath the vena cava.

Capsular artery.

The *middle capsular* or *suprareneal artery* is a small branch which runs almost transversely outwards to the suprareneal body from the renal and diaphragmatic arteries. It is of large size in the fœtus.

Spermatic artery is remarkable;

The *spermatic artery* of the testicle (fig. 138, *d*) is remarkable for its small size in proportion to its length, and for its leaving the cavity of the abdomen. The part in the abdomen is straight, but that in the cord is tortuous.

course to the testicle;

From its origin below the renal, the vessel passes downwards along the posterior wall of the abdomen to the internal abdominal ring, where it enters the spermatic cord. In its course beneath the peritoneum the vessel runs along the front of the psoas, crossing over the ureter; and on the right side it passes over the vena cava. It is

accompanied by the spermatic vein, and the spermatic plexus of nerves. In the fœtus before the testicle leaves the abdomen the spermatic artery is very short, but the vessel elongates as the testis is removed from its original position. condition in the fœtus;

In the female the corresponding artery (*ovarian*) descends into the pelvis to end in the ovary and the uterus. in the female.

The *parietal branches* of the aorta are the diaphragmatic, lumbar, and middle sacral. Branches to wall of abdomen.

The *diaphragmatic arteries* (inferior phrenic; fig. 138, *a*) are frequently united together at their origin, or with the cœliac axis. They course upwards along the posterior part of the under surface of the diaphragm, the left artery passing behind the œsophageal opening, and the right behind the vena cava. Each ends in two branches:—One (internal) passes onwards towards the front of the diaphragm, and anastomoses with its fellow, and with the superior phrenic and musculo-phrenic branches of the internal mammary. The other (external) is larger, and is directed outwards to the side of the muscle, where it communicates with the intercostal arteries. Inferior phrenic: course of left and right; distribution;

Branches. Small offsets to the suprarenal body from the external division of this artery are named *superior capsular*. Some twigs are given by the left artery to the œsophagus, and by the right to the vena cava. small offsets.

On the under-surface of the diaphragm are two branches of the internal mammary artery of the thorax, one, *superior phrenic*, accompanies the phrenic nerve, and ramifies over the middle of the muscle; the other, *musculo-phrenic*, appears opposite the ninth cartilage, and supplies the upper costal slips of the diaphragm. Other arteries to diaphragm.

The other parietal branches of the aorta, viz., lumbar and middle sacral, are not learnt in this stage: the former will be examined after the lumbar plexus (p. 374), and the latter in the pelvis (p. 400).

The COMMON ILIAC ARTERY (fig. 138, *g*) is directed downwards and outwards from the bifurcation of the aorta, and divides into two large trunks opposite the fibro-cartilage between the last lumbar vertebra and the sacrum;—one of these (*external iliac*) supplies the lower limb, and the other (*internal iliac*) enters the pelvis. Placed obliquely on the vertebral column, the vessel measures about two inches in length. It is covered by the peritoneum, and is crossed by branches of the sympathetic nerve, and sometimes by the ureter. It is accompanied by a vein of the same name. Usually it does not furnish any named branch, but it may give origin to the ilio-lumbar artery. On opposite sides the vessels have some differences. Common iliac artery: extent and termination; relations; usually no branches.

The *right artery* has the vena cava to its outer side above, and near its termination touches the psoas muscle. The companion vein (*p*) is at first beneath, but becomes external to the artery at the upper part; and beneath the right artery also is the left common iliac vein. The *left artery* is crossed by the superior hæmorrhoidal Differences between right and left vessel.

vessels ; and its companion vein is situate to its inner side. It lies close to the psoas muscle throughout.

Variations in length.

The *length* of the common iliac artery ranges from less than half an inch to four inches and a half ; but in the majority of instances it varies between one inch and a half and three inches (R. Quain).

External iliac leads to lower limb; extent and direction;

The EXTERNAL ILIAC ARTERY (fig. 138, *h*) is the first part of the vessel leading to the lower limb, and is contained in the cavity of the abdomen. Its extent is from the bifurcation of the common iliac to the lower border of Poupart's ligament, where it becomes the common femoral. And its direction would be indicated, on the surface of the abdomen, by a line from the left of the umbilicus to a point midway between the symphysis pubis and the anterior superior iliac spine.

surface marking.

relations with parts around,

The vessel lies above the brim of the pelvis in its course to Poupart's ligament, and is covered closely by the peritoneum and the subperitoneal fat. The right artery is crossed by the lower end of the ileum, and the left by the pelvic colon. To its outer side is the psoas, except at its termination under Poupart's ligament, where it lies over the muscle. A chain of lymphatic glands is placed along the front and the inner side of the artery.

with other vessels,

Close to its origin the artery is often crossed by the ureter ; and near Poupart's ligament the vas deferens bends down along its

with nerve,

inner side ; while the spermatic vessels, and the genital branch of the genito-crural nerve lie on it for a short distance.

and veins.

The external iliac vein (*r*) is behind the artery above, but gradually comes forwards and gains its inner side over the pubis. The circumflex iliac vein crosses it nearly an inch above Poupart's ligament.

Two named branches:

Branches. Two considerable branches, deep epigastric and deep circumflex iliac, arise about a quarter of an inch from the end of the artery, and are distributed to the wall of the abdomen (p. 284).

unnamed offsets.

Some small unnamed twigs are given to the psoas muscle and the lymphatic glands.

Origin of branches varies:

Peculiarities in branches. The epigastric and circumflex iliac branches may wander over the lower inch and a half or two inches of the artery. The obturator artery is often derived from the external iliac, in which case it

occasional branches.

generally arises in common with the deep epigastric artery (p. 294.) In rare cases the internal circumflex artery of the thigh is given off from the epigastric or the lower part of the external iliac trunk.

Veins of the abdomen, except vena portæ.

ILIAC VEINS AND VENA CAVA (fig. 138). The larger veins of the abdomen correspond so closely with the arteries, both in number, extent, and relations, as to render unnecessary much detail in their description. As the veins increase in size from the circumference towards the centre of the body, those most distant from the heart will be first referred to.

Anatomy of external iliac vein:

The EXTERNAL ILIAC VEIN (*r*) is a continuation of the common femoral vein beneath Poupart's ligament. It has an extent like the artery of the same name, and ends by uniting with the vein from the pelvis (internal iliac), to form the common iliac vein. On the pubis

it is internal to its companion artery, and lies between the psoas and pectineus muscles; but as it ascends it gradually passes behind the artery. position to artery;

The veins opening into it are the epigastric and circumflex iliac and a *pubic branch* from the obturator vein. tributaries.

The COMMON ILIAC VEIN (*p*) ascends by the side of its accompanying artery, the right almost vertically, and the left obliquely, to the front of the body of the fifth lumbar vertebra (the right half), where it blends with its fellow in one trunk—the vena cava. Common iliac veins form cava:

The *right vein* is the shorter, and lies at first behind, but afterwards outside the artery of the same name. The *left* is internal to and below the artery of its own side, and crosses beneath the right common iliac artery to the commencement of the vena cava. difference in length and relations;

Each vein receives the ilio-lumbar branch; and the common iliac of the left side is joined by the middle sacral vein. tributaries.

The INFERIOR OR ASCENDING VENA CAVA (*m*) collects and conveys to the heart the blood of the lower half of the body. Taking origin opposite the fifth lumbar vertebra, lower than the bifurcation of the aorta, this large vein ascends on the right side of the arterial trunk, and reaches the heart by perforating the diaphragm. Its relations to surrounding parts have been already noticed (p. 320), but the description may be again referred to, as the position of the branches of the aorta to it can be better seen now. Vena cava inferior: extent; relations;

TRIBUTARIES. The cava receives parietal branches (lumbar and diaphragmatic) from the wall of the abdomen and the diaphragm; and visceral branches from the testicle, the kidney, the suprarenal body, and the liver. receives branches from abdomen,

The veins belonging to the stomach, the intestinal canal, the spleen, and the pancreas, are united to form the vena portæ (p. 334); and the blood contained in those vessels reaches the cava by the hepatic veins, after it has circulated through the liver. except those of digestive apparatus.

The *spermatic vein* (*o*) enters the abdomen by the internal abdominal ring, after forming the spermatic plexus in the cord. At first there are two branches in the abdomen, which lie on the sides of the spermatic artery; but these soon join into one trunk. On the left side it opens into the renal vein at a right angle, and there is generally a small valve over the aperture; on the right side it enters the inferior cava below the renal vein. As the vein ascends to its destination, it receives one or more branches from the wall of the abdomen, and the fat about the kidney. Spermatic vein; ends differently on left and right sides; branches:

In the female the corresponding vein (*ovarian*) has the same ending as in the male, and it forms a plexus in the broad ligament of the uterus. Valves are absent from the vein and its branches, but commonly there is one at its union with the renal. vein in the female.

The *renal* or *emulgent vein* (*n*) is of large size, and joins the vena cava at a right angle. It commences by many branches in the kidney; and the trunk resulting from their union is superficial to the renal artery. Renal vein; position to artery,

difference on two sides. The right vein is the shorter, and usually joins the cava a little lower than the other. The left vein crosses the aorta close to the origin of the superior mesenteric artery; it receives the left spermatic and suprarenal veins.

Suprarenal ends differently on each side. The *suprarenal vein* is of considerable size when it is compared with the body from which it comes. The right opens into the cava, and the left into the renal vein.

Hepatic veins; before noticed. The *hepatic veins* enter the vena cava where it is contact with the liver. They are described on pp. 348 and 350.

Lumbar veins. The *lumbar veins* correspond in number and course with the arteries of the same name. They will be dissected later.

Phrenic veins. The *diaphragmatic veins* (inferior), two with each artery, spring from the upper surface of the diaphragm. They join the cava either as one trunk or two.

DEEP MUSCLES OF THE ABDOMEN.

The deep muscles in the interior of the abdomen are the psoas, iliacus, and quadratus lumborum.

Psoas magnus: situation; The PSOAS MAGNUS (fig. 138, F.) reaches from the lumbar vertebræ to the femur, and is situated in the abdomen and in the thigh.

origin from lumbar vertebræ; The muscle *arises* from the front of the transverse processes of the lumbar vertebræ, from the bodies and intervertebral discs of the last dorsal and all the lumbar vertebræ by five fleshy pieces—each piece being connected with the intervertebral substance and the borders of two contiguous vertebræ, and from tendinous bands over the blood-vessels opposite the middle of the vertebræ. The fibres give rise to a roundish belly, which gradually diminishes towards Poupart's ligament, and ends below in a tendon on the outer aspect, which receives also most of the fibres of the iliacus, and passes beneath Poupart's ligament to be *inserted* into the small

insertion into femur; trochanter of the femur.

relations in front, The abdominal part of the muscle has the following relations:—In front are the internal arched ligament of the diaphragm, the kidney with its vessels and duct, the spermatic vessels and the genito-crural nerve, and, near Poupart's ligament, the ending of the external iliac artery: beneath these, the muscle is covered by the

behind, inner part of the iliac fascia. Behind, the muscle is in contact with the transverse processes of the vertebrae, with the quadratus lumborum, and with the hip-bone.

of outer border, The outer border touches the quadratus and iliacus; and branches of the lumbar plexus issue from beneath it. The inner border is partly connected to the vertebræ, and is partly free along the margin

of inner border; of the pelvis;—along the attached part of this border lies the sympathetic nerve, with the cava on the right, and the aorta on the left side; along the free or pelvic part are the external iliac vessels.

lumbar nerves in its substance; The nerves of the lumbar plexus lie between the slips of origin from the transverse processes.

use to bend hip-joint *Action.* If the femur is free to move it is raised towards the

belly; and in flexing the hip-joint the psoas is always combined with the iliacus. with iliacus,

When the lower limbs are fixed the two muscles will draw forwards the lumbar part of the spine, and bend the hip-joints, as in stooping to the ground. One muscle under the same circumstances can incline the spine laterally. or to bend trunk on the limb.

The PSOAS PARVUS (fig. 138, E) is a small inconstant muscle, with a long tendon, which is placed on the front of the large psoas. Its fibres *arise* from the bodies of the last dorsal and first lumbar vertebræ, with the intervening fibro-cartilage. Its tendon becomes broader below, and is *inserted* into the ilio-pectineal eminence and the brim of the pelvis, joining the iliac fascia. Psoas parvus: origin; insertion;

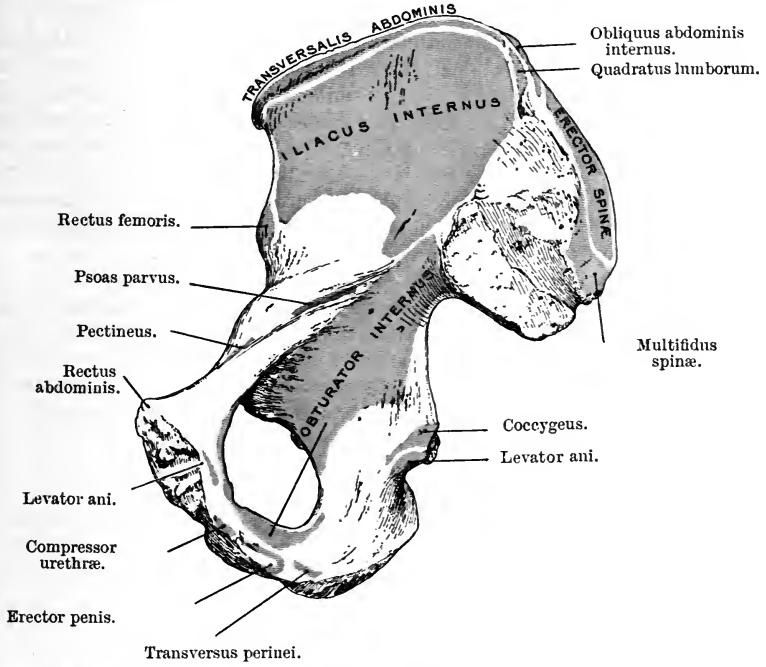


FIG. 139.—OS INNOMINATUM—INNER AND ANTERIOR VIEW.

Action. This muscle aids in flexing the lumbar portion of the spine, either drawing forwards the upper part of the trunk, or raising the front of the pelvis, according to which end is fixed. use.

The ILIACUS MUSCLE (fig. 138, H) occupies the iliac fossa on the inner aspect of the hip-bone, and is blended inferiorly with the psoas. It is triangular in form, and has a fleshy *origin* from the iliac fossa (fig. 139), and slightly from the ala of the sacrum and the anterior sacro-iliac ligament. The fibres pass obliquely inwards to the tendon of the psoas, uniting with it down to its insertion into the Iliacus has the form of the iliac fossa; origin; insertion;

femur ; and a few have a separate attachment to the femur below the small trochanter (fig. 61, p. 158).

parts covering it on two sides, beneath it ; Above Poupart's ligament the muscle is covered by the iliac fascia ; and over the right iliacus are placed the cæcum and ascending colon, over the left, the sigmoid flexure : beneath it is the hip-bone. The inner margin is overlapped by the psoas ; and the anterior crural nerve lies between the two. The relations of the united psoas and iliacus below Poupart's ligament are given with the dissection of the thigh (p. 167).

use to bend hip-joint. *Action.* The iliacus raises the femur with the psoas when the limb is moveable, and bends forwards the pelvis when the limb is fixed.

The psoas and iliacus may be regarded as two heads of one muscle —the ILIO-PSOAS.

Quadratus lumborum : origin ; The QUADRATUS LUMBORUM (fig. 138, G) is a short, flattened muscle between the pelvis and the last rib. About two inches wide below, it arises from the ilio-lumbar ligament, and from the iliac crest behind, and for an inch outside that band (fig. 139) ; it generally receives in addition two or three slips from the transverse processes

insertion ; of the lower lumbar vertebræ. The fibres ascend to be inserted by distinct fleshy and tendinous slips into the apices of the transverse processes of the upper four lumbar vertebræ, and into the lower border of the last rib for a variable distance.

is contained in a sheath ; This muscle is encased in a sheath derived from the fascia lumborum. Crossing the surface are branches of the lumbar plexus, together with the last dorsal nerve and its vessels. Behind the quadratus is the erector spinæ muscle.

use of both muscles, *Action.* Both muscles keep straight the spine (one muscle antagonising the other) ; and by fixing the last rib they aid in the more complete contraction of the diaphragm.

of one. One muscle will incline laterally the lumbar region of the spine to the same side, and depress the last rib.

Fascia of the quadratus. *Fascia of the quadratus.* Covering the surface of the quadratus is a thin membrane, derived from the hinder aponeurosis of the transversalis abdominis (anterior layer of the fascia lumborum), which passes in front of the quadratus to be fixed to the tips and borders of the lumbar transverse processes, to the ilio-lumbar ligament below, and to the last rib above. A thickened band of this fascia forms the external arched ligament, to which the diaphragm is connected.

Iliac fascia covers ilio-psoas ; attachments below, ILIAC FASCIA. This fascia covers the double flexor of the hip-joint, and is fixed to the bone on each side of the muscle. The membrane is strongest opposite the pelvis, where it is attached to the iliac crest on the outer side, and to the brim of the cavity on the inner side : it receives a strong accession from the tendon of the

and above. psoas parvus when that muscle is present. Over the upper part of the psoas it becomes thin, and is fixed on the one side to the lumbar vertebræ ; while on the other it is blended with the fascia over the quadratus ; and above, it joins the internal arched ligament of the diaphragm. Its disposition at Poupart's ligament, and the part

that it takes in the formation of the crural sheath, have been before explained (p. 293).

Dissection. The student is now to remove the right kidney and to clean the lymphatic glands lying along the vertebræ, and to trace upwards some lymphatic vessels to *the thoracic duct.* Trace the lymphatics,

To show the origin of the duct, the diaphragm is to be divided over the aorta, and its pillars are to be thrown to the sides: a piece may be cut out of the aorta opposite the first lumbar vertebra. The beginning of the duct (receptaculum chyli), and the lower end of the large azygos vein may be well seen: and the two are to be followed upwards into the thorax. and the receptaculum, and

On the left side the student may trace the splanchnic nerves and the small azygos vein through the pillar of the diaphragm, and may show the knotted cord of the sympathetic nerve entering the abdomen beneath the arch over the psoas muscle. splanchnic nerves.

Lymphatic Glands. A chain of glands is placed along the side of the external iliac artery, and along the front and sides of the lumbar vertebræ; they are connected by short tubes, which increase in size and diminish in number, and opposite the first lumbar vertebra form one principal trunk which enters the thoracic duct. Into the glands the lymphatics of the lower limbs, and those of some of the viscera and of the wall of the abdomen are received. Lumbar lymphatic glands: ducts end in one trunk.

Another cluster of large glands surrounds the cœliac axis, and covers the upper end of the abdominal aorta. They are distinguished as the *cœliac glands*, and receive the lymphatics of the stomach, spleen, pancreas, and great part of the liver. Their ducts unite with those of the mesenteric glands, and give rise to one or more large trunks, which pass to the common thoracic duct. Cœliac glands: ducts join those from intestine.

Receptaculum chyli. The thoracic duct begins in the abdomen by the union of three or four large lymphatic trunks. Its commencement is marked by a dilatation, which is placed on the right side of the aorta, opposite the first or second lumbar vertebra. The duct enters the thorax by passing through the diaphragm with the aorta. Beginning of the thoracic duct.

THE SPINAL AND SYMPATHETIC NERVES.

The spinal nerves of the loins enter into a plexus, and supply the limb and the contiguous portions of the trunk.

Dissection (fig. 140, p. 373). The lumbar nerves and their plexus are to be learnt on the left side, although the woodcut shows them on the right side; and to bring them into view, the dissector should cut through the external iliac vessel, and afterwards scrape away the psoas. For the most part the fleshy fibres may be removed freely; but a small branch (accessory of the obturator) should be first looked for at the inner border of the muscle. On, or in the substance of, the quadratus lumborum a communication may be sometimes found between the last dorsal and the first lumbar nerve. Dissection of the lumbar plexus on left side,

The cord of the sympathetic nerve lies along the edge of the psoas, and offsets of it join the spinal nerves; these are to be followed back along the lumbar arteries. with sympathetic.

On the right side the psoas is to be left untouched, in order that the place of emergence from it of the different offsets of the plexus may be noticed.

Four lumbar nerves enter plexus

LUMBAR SPINAL NERVES. The anterior primary branches of the lumbar nerves, five in number, increase in size from above down, and are joined by filaments of the sympathetic near the intervertebral foramina. With the exception of the last, they enter the lumbar plexus, having previously given off branches for the supply of the quadratus lumborum and psoas muscles.

and supply muscles:

fifth to the sacral plexus.

The fifth nerve receives a communicating branch from the fourth, and is to be followed into the pelvis to its junction with the sacral plexus. After the two are united, the name *lumbo-sacral cord* is applied to the common trunk.

Plexus how formed;

The LUMBAR PLEXUS (fig. 140) is formed by the intercommunication of the first four lumbar nerves. Contained in the substance of the psoas, near the posterior surface it consists of loops between the several nerves, and increases in size from above downwards, like the individual nerves. Superiorly it is sometimes united by a small branch with the last dorsal nerve; and inferiorly it joins the sacral plexus through the large lumbo-sacral cord.

situation;

connections with nerves.

Six branches, viz.:—

The *branches* of the plexus are six in number, and supply the lower part of the abdominal wall and the muscular covering of the spermatic cord, the fore and inner parts of the thigh, and the inner side of the leg.

Two cutaneous branches.

The first two branches (ilio-hypogastric and ilio-inguinal) end as cutaneous nerves of the hip, the lower part of the abdomen, the scrotum, and the thigh.

Ilio-hypogastric:

1. The *ilio-hypogastric branch* (fig. 140, *f*) is derived from the first nerve, and appears at the outer border of the psoas muscle, near the upper end. It is directed over the quadratus lumborum to the iliac crest, and enters the wall of the abdomen by piercing the transversalis muscle. Its termination in the integuments of the buttock and abdomen, by means of an iliac and a hypogastric branch has been already mentioned (pp. 110, 263 and 275).

course in abdomen.

Ilio-inguinal arises with preceding,

2. The *ilio-inguinal branch* (*g*) arises with the preceding from the first nerve, and issues from the psoas nearly at the same spot. Of smaller size than the ilio-hypogastric, this branch courses outwards over the quadratus and iliacus muscles towards the front of the iliac crest, where it pierces the transversalis. The farther course of the nerve in the abdominal wall, and its distribution to the scrotum and the thigh, are before noticed (pp. 264 and 275).

and accompanies it.

Genito-crural

3. The *genito-crural nerve* (*h*) is distributed to the cremaster muscle and the limb. It arises from the second lumbar nerve, and from the connecting loop between the first two; issuing from the front of the psoas, it descends on the surface of the muscle, and divides into genital and crural branches. Sometimes the nerve is divided in the psoas, and the branches perforate the muscle separately.

pierces psoas,

and divides into

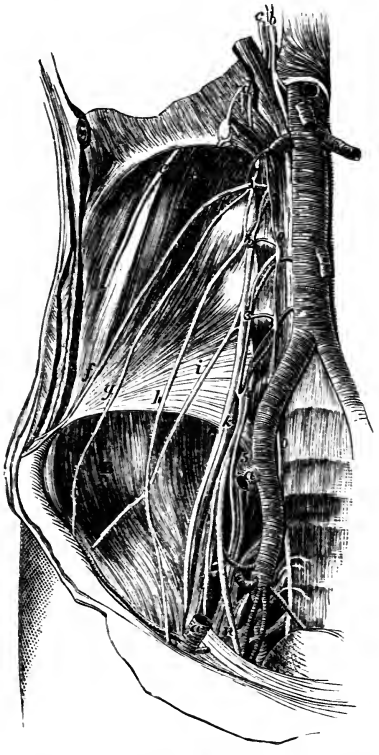
genital and

The *genital branch* descends on the external iliac artery, and furnishes offsets around it: it passes from the abdomen with the

spermatic vessels, and is distributed in the cremaster muscle. In the female the nerve is lost in the round ligament.

The *crural branch* issues beneath Poupart's ligament to supply the integument of the thigh (p. 140). crural branch.

4. The *external cutaneous nerve* of the thigh (*i*) arises from the loop between the second and third nerves, and appears about the middle of the outer border of the psoas. The nerve then crosses the iliacus to the interval between the anterior iliac spinous processes, and leaves the abdomen beneath Poupart's ligament, to be distributed on the outer aspect of the limb (p. 140).



Course of external cutaneous to the thigh.

5. The *anterior crural nerve* (*k*) is the largest offset of the plexus, and supplies branches mainly to the extensor muscles of the knee-joint, and to the integuments of the front of the thigh and inner side of the leg. Taking origin from the second, third, and fourth nerves, this large trunk appears towards the lower part of the psoas, where it lies between that muscle and the iliacus. It passes from the abdomen beneath Poupart's ligament; but before the final branching in the thigh (p. 160), the nerve sends off the following twigs:—

Origin of anterior crural; position in the abdomen; its branches

Some small *branches to the iliacus* are furnished from the outer side of the nerve.

A *branch to the femoral artery*, the place of origin

Fig. 140. — Dissection of the Lumbar Plexus and its Branches (Illustrations of Dissections).

a. External iliac artery, cut across.
b. Thoracic duct.
c. Azygos veins.

Nerves:

The figures 1 to 5 mark the trunks of the five lumbar nerves.
d. Splanchnic nerves.
e. Last dorsal.
f. Ilio-hypogastric.
g. Ilio-inguinal.
h. Genito-crural.
i. External cutaneous.
k. Anterior crural.
l. Accessory to obturator.
n. Obturator.
o. Gangliated cord of the sympathetic.

to iliacus, to femoral artery.

of which varies much, is distributed around the upper part of that vessel.

Obturator in the abdomen;

6. The *obturator nerve* (*n*) is distributed chiefly to the abductor muscles of the thigh (p. 164). Arising in front of the anterior crural from the second, third, and fourth nerves in the plexus (sometimes not from the second), it makes its appearance at the inner border of the psoas near the sacro-iliac articulation. Escaped from beneath the muscle, the nerve crosses the side of the pelvis below the external

ends in the thigh;

iliac, but above the obturator vessels, and enters the thigh through the aperture at the top of the thyroid foramen. Occasionally the the obturator gives origin to the following branch:—

occasionally an accessory branch.

The *accessory obturator nerve* (*l*) arises from the trunk of the obturator, or from the third and fourth nerves of the plexus. Its course is along the inner border of the psoas, beneath the investing fascia, and over the hip-bone to the thigh, where it ends by joining the obturator nerve, and supplying the hip-joint (p. 163).

Sympathetic cord in the abdomen

GANGLIATED CORD OF THE SYMPATHETIC (fig. 140, *o*). The lumbar part of the gangliated cord of the sympathetic is continuous with the thoracic part beneath the internal arched ligament of the

joins that in thorax;

diaphragm. It lies on the front of the spinal column, along the inner border of the psoas muscle, and is somewhat concealed on the

has four or five ganglia;

right side by the vena cava, on the left by the aorta. The cord has four or five oval ganglia, which supply connecting and visceral branches.

branches to the spinal nerves,

Connecting branches. From each ganglion two small branches are directed backwards along the centre of the body of the vertebra, with the lumbar artery; these unite with one or two spinal nerves near the intervertebral foramen. The connecting branches are long in the lumbar region, in consequence of the gangliated cord being carried forward by the psoas muscle.

and to the viscera.

Branches of Distribution. Most of the internal branches throw themselves into the aortic and hypogastric plexuses, and so reach the viscera indirectly. Some filaments enter the vertebræ and their connecting ligaments.

Last dorsal nerve:

LAST DORSAL NERVE (fig. 138, p. 363, and fig. 140, *e*). The anterior primary branch of the last dorsal resembles the intercostal nerves in its distribution, but differs from them in not being contained in an intercostal space. Lying below the last rib, the nerve

course to wall of the abdomen;

is directed outwards across the upper part of the quadratus lumborum, but beneath the external arched ligament and the fascia of the quadratus. At the outer border of that muscle it perforates the middle layer of the fascia lumborum, and enters the wall of the abdomen, where it ends in an abdominal and a lateral cutaneous branch (pp. 110 and 274). The first lumbar artery accompanies it.

branch to muscle.

Near the spine it furnishes a small branch to the quadratus muscle; and it may communicate by means of this with the first lumbar nerve.

Lumbar arteries five in number on each side:

The LUMBAR ARTERIES of the aorta are furnished to the back, the spinal canal, and the wall of the abdomen: they resemble

the aortic intercostals in their course and distribution. Commonly five in number on each side, they arise from the back of the aorta, and the vessels of opposite sides are sometimes joined in a common trunk. They pass backwards over the hollowed surface of the bodies of the last dorsal and upper four lumbar vertebræ, and beneath the pillar of the diaphragm and the psoas, to reach the interval between the transverse processes, where each ends in an abdominal and a dorsal branch. The arteries of the right side lie beneath the vena cava.

course; and termination in

The *posterior* or *dorsal branches* continue to the back between the transverse processes, and supply offsets to the muscles and to spinal canal.

a branch to the back,

The *anterior* or *abdominal branches* are directed outwards, and enter the posterior part of the abdominal wall, where they are distributed (p. 283). The first lies with the last dorsal nerve across the front of the quadratus lumborum, but the others usually pass behind that muscle. Offsets are furnished to the psoas and quadratus muscles, and to the subperitoneal fat, and they anastomose with branches of the renal, capsular, spermatic, right and left colic, and some other visceral arteries.

and a branch to the wall of the abdomen.

The LUMBAR VEINS are the same in number, and have the same course as the arteries. Commencing by the union of a dorsal and an abdominal branch at the root of the transverse process, each trunk is directed forwards to the vena cava. They open into the back of the cava, either singly, or conjointly with those of the opposite side. On the left side the veins are longer than on the right, and pass beneath the aorta.

The veins resemble the arteries, and open into the cava; left longer.

Around the transverse processes, and beneath the psoas muscles, the lumbar veins communicate freely with one another, with the ilio-lumbar, and with the common iliac, so as to form a plexus of veins. Issuing above from the plexus is a branch, the *ascending lumbar vein*, which joins the azygos vein of the corresponding side of the body.

A plexus around the transverse processes.

BEGINNING OF THE AZYGOS VEINS. The azygos vein begins on each side above the first lumbar vertebra by the above-mentioned ascending lumbar vein; and it is often joined by a branch of communication with the inferior cava or the renal vein. The *right vein* enters the thorax usually with the thoracic duct and the aorta, to the right of which it lies. The *left vein* passes through the pillar of the diaphragm, or sometimes through the aortic opening.

Origin of azygos veins: entrance into thorax.

The anatomy of these veins in the thorax is given at p. 483.

CHAPTER VII.

DISSECTION OF THE PELVIS.

SECTION I.

THE CAVITY OF THE PELVIS.

Dissection. For the convenience of examination the pelvis should now be detached from the rest of the trunk by cutting through the disc between the third and fourth lumbar vertebral and severing the soft parts and ligamentous tissues as required. The lower limbs will already have been removed.

Definition and situation.

The cavity of the pelvis is the part of the general abdominal space situate below the brim of the true pelvis.

Boundaries; behind and before;

Boundaries. The space is surrounded by the firm ring of the pelvic bones: it is bounded behind by the sacrum and coccyx, with the pyriformes muscles and the sacro-sciatic ligaments; and laterally and in front by the hip-bones covered by the internal obturator muscles.

below.

Inferiorly, or towards the perineum, the cavity is limited by the fascia passing from the wall to the viscera, and by the levatores ani and coccygei muscles: it is only in this direction, where the bounding structures are to some extent moveable, that the size of the space can be appreciably altered.

Contents.

Contents. In the pelvis are contained the urinary bladder with the beginning of the urethra, the lower end of the large intestine or the rectum, and some of the generative organs, according to the sex. The viscera are supplied with vessels, nerves, and lymphatics; and the serous membrane is reflected over them.

THE PERITONEUM, THE PELVIC FASCIA AND MUSCLES OF THE OUTLET.

Directions. The student will now in a good light make a detailed examination of the cavity of the pelvis and of its lining peritoneum.

*FOSSÆ OF THE PELVIS (fig. 141). The pelvic colon terminates in the *rectum* at the back of the pelvis opposite the third sacral vertebra, and at that point the bowel ceases to have a mesentery.

The peritoneum.

The peritoneum invests the sides and front of the rectum in its upper third, and then, leaving its sides, continues down the front of the middle third of the bowel, when leaving it altogether, it is reflected on to the upper part of the seminal vesicles and thence on to the upper surface of the bladder in the male, or on to the upper

* For the subjoined description the Editor is much indebted to work of Dixon and Birmingham.

part of the vagina where it adjoins the uterus and thence along the back of the uterus in the female.

There is thus produced a deep hollow at the back of the pelvis which is called the *recto-genital pouch*, or the *recto-vesical* in the male and *recto-uterine* (*Douglas's Pouch*) in the female. Recto-genital pouch.

When the bladder and rectum are distended the floor of this

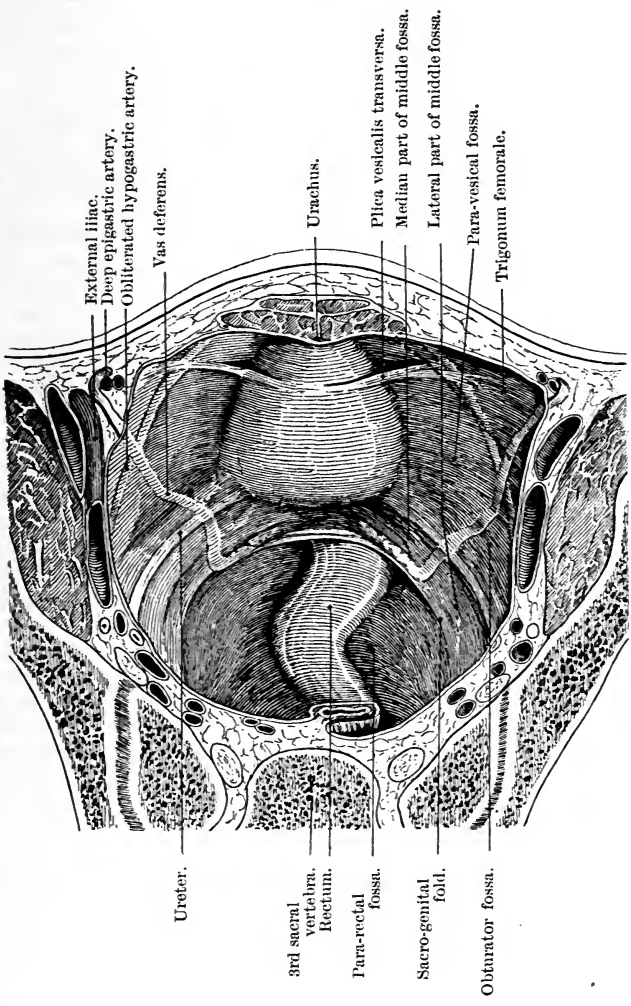


FIG. 141.—THE INTERIOR OF THE PELVIS SEEN FROM ABOVE (DIXON AND BIRMINGHAM). (FROM THE JOURNAL OF ANATOMY AND PHYSIOLOGY, VOL. 36.)

pouch rises and, in moderate distension of both, the reflection of peritoneum from the rectum on to the seminal vesicles is about an inch above the prostate and three inches above the anus.

On either side of the rectum is a hollow, occupied in varying Para-rectal fossa.

degrees by the bowel when distended, which is styled the *para-rectal fossa.*

Sacro-genital fold.

The para-rectal fossa is limited in front by a fold (the *sacro-genital fold*) which passes from the front of the sacrum on either side on to the seminal vesicles or cervix uteri, as the case may be. It is a strong fold containing fibrous and some unstriped muscular tissue.

Contains unstriped muscle.

Middle fossa.

In front of and above the sacro-genital fold along the wall of the pelvis will be seen a fold produced by the ureter as it passes downwards to the lateral angles of the bladder. The slight hollow between the sacro-genital fold and the ureter is spoken of as the *middle fossa of the pelvis.*

Para-vesical fossa.

In front of the ureter is a hollow on either side of the empty bladder which is appropriately named the *para-vesical fossa.* In the male the vas deferens will be seen passing downwards along the side of the pelvis towards the back of this fossa.

Transverse vesical fold.

Passing outwards from the upper part of the bladder when empty, across the pelvic floor on to the side of the pelvis at the fore part of the para-vesical fossa, is a fold (the *transverse vesical fold*) which passes over the brim of the pelvis towards the internal abdominal ring and often corresponds to the course of the superior vesical artery.

From the summit and upper surface of the bladder the peritoneum is reflected on to the wall of the pelvis and abdomen leaving the front and lower part of that organ entirely uncovered by peritoneum.

Distended bladder.

When the bladder is distended and rises into the abdomen a part of this uncovered surface is in contact with the anterior abdominal wall above the pubic bones, and the bladder may be opened through it without injury to the peritoneum.

Bladder in the child.

It should be pointed out that in the child the bladder is only accommodated to a small extent in the pelvis and its anterior surface is in contact with the anterior abdominal wall above the pubis, having no peritoneal investment in front.

False ligaments of the bladder.

The reflectives of the peritoneum on to the walls of the pelvis are commonly described as the *false ligaments of the bladder*, but it is not a satisfactory terminology. The *superior false ligament* is the peritoneum covering the uraches which extends from the summit of the bladder to the anterior abdominal wall. The *lateral false ligaments* are the peritoneal reflections on each side from the bladder to the pelvic wall ; and the *posterior false ligaments* are simply the peritoneal coverings of the sacro-genital folds.

Outline of the fascia of the pelvis.

THE PELVIC FASCIA. Lining the wall of the pelvis is a thin fascia (pelvic), which covers the obturator internus and pyriformis muscles, and sends a process inwards to support the viscera.

Steps to define the pelvic fascia :

Dissection. To bring into view the pelvic fascia, the external iliac vessels, and the psoas (if this has not been removed in the dissection of the lumbar plexus), are to be taken away *on the left side of the body.* The obturator vessels and nerve are to be cut

in the pelvis,

through on the same side ; and the peritoneum being detached from the wall of the pelvis, the fascia will be seen on scraping away with the handle of the scalpel a quantity of fat. The fascia is strong in part but is thin towards the back and in this part the student

should proceed cautiously. By this proceeding the membrane is dissected in its upper half, or as low as the situation of the portion (recto-vesical) which is directed inwards to the viscera.

To display the lower half, the student must raise the outlet of the pelvis ; and, should the perineum be undissected, the fat must be taken from the ischio-rectal fossa. The lower part of the pelvic

and the perineum :

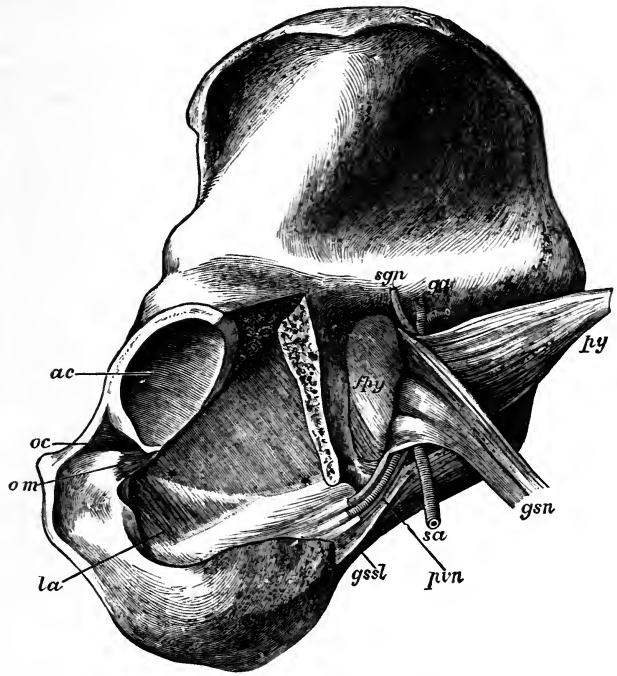


Fig. 142.—Dissection of the Pelvic Fascia (drawn by C. F. Beadles).

ac. Acetabulum.

o c. Aperture of canal for obturator vessels and nerves, bounded below by *o m*, the upper end of the obturator membrane, the greater part of which has been taken away. Below these, the fascia of the obturator internus is exposed by the removal of a portion of the bone and the muscle.

** Line along which the recto-vesical fascia is given off from the inner side of the obturator fascia.

l a. Tendinous fibres of origin of the levator ani, showing through the obturator fascia.

f py. Fascia of the pyriformis.

s g n. Superior gluteal nerve.

g a. Gluteal artery.

py. Pyriformis muscle.

y s n. Great sciatic nerve.

s a. Sciatic artery.

p v n. Pudic vessels and nerve, entering the sheath in the obturator fascia.

g s s l. Great sacro-sciatic ligament.

fascia will now appear on the outer side of that fossa, as it covers the obturator muscle.

To see the outer surface of the fascia (fig. 142), the obturator externus muscle and the obturator membrane should now be removed, with the exception of a small portion of the latter at the

from outer side ;

upper end of the thyroid foramen, where it bounds the aperture through which the vessels and nerve issue. A portion of the bone is then to be cut out behind the foramen, and extending into the small sciatic notch, as in the figure ; and the obturator internus muscle is to be carefully separated from the fascia and taken away.

and over pyriformis. Lastly, by turning back the pyriformis muscle and the great sciatic nerve, a thin piece of the fascia covering those structures will be exposed in the great sacro-sciatic foramen (*f py*).

Pelvic fascia divided into three parts, viz. :— The PELVIC FASCIA is a thin membrane which covers the deep surface of the muscles bounding the cavity, and may be described in three parts. Two of these are parietal and line the wall of the pelvis,—one covering the obturator internus muscle is named the *obturator fascia*, and the other extending over the pyriformis muscle is the *fascia of the pyriformis*. The third portion of the fascia is reflected inwards from the wall of the pelvis on the upper surface of the levator ani and enters into the formation of the floor of the pelvis, and supports the rectum and bladder, whence it is known as the *recto-vesical fascia*.

Obturator fascia : attachments ; The *obturator fascia* (fig. 142) invests closely the pelvic portion of the obturator internus muscle, and is fixed to the bone around the attachment of the fleshy fibres. Thus, it is attached above to the ilio-pectineal line of the hip-bone between the sacro-iliac articulation and the upper end of the obturator foramen ; at the latter spot it joins the obturator membrane over the edge of the muscle, so as to form the floor of the canal transmitting the obturator vessels and nerve ; and in front it is fixed to the body of the pubis, following the border of the muscle. Below, it is inserted into the inner side of the inferior ramus of the pubis, and the ramus and tuberosity of the ischium in conjunction with the falciform process of the great sacro-sciatic ligament. Behind, it is fixed to the hip-bone along the anterior margin of the great sciatic notch ; and between the ischial spine and the tuberosity, it is united with the great sacro-sciatic ligament, where the obturator internus issues from the pelvis.

relations. From the inner surface of this membrane the recto-vesical fascia is given off, along a curved line extending from the ischial spine to the upper and inner part of the obturator foramen (fig. 142, * *). Above this line the obturator fascia bounds the cavity of the pelvis at the side, and is in contact with the peritoneum ; while below, it looks into the ischio-rectal fossa, except over a small space in front, where it is closely united with the pubic origin of the levator ani (*l a*).

Fascia of pyriformis. The *fascia of the pyriformis* (*f py*) is very thin, and is continued backwards from the hinder part of the obturator fascia to the sacrum, passing over the front of the sacral plexus and the pyriformis muscle, but beneath the internal iliac vessels, by whose gluteal, sciatic and pudic branches it is perforated.

Recto-vesical fascia later. The *recto-vesical fascia* may now be seen in part by looking into the pelvis ; and the student may notice a whitish line extending from the lower part of the pubis, close to the symphysis, to the

ischial spine. This line corresponds in its hinder part to the origin of the recto-vesical fascia from the obturator fascia; but in front, the levator ani extends upwards between the two laminæ of fascia. The disposition of this part of the fascia will be better seen after the hip-bone has been taken away.

Dissection. To obtain a side view of the pelvis (fig. 143, p. 382), it will now be necessary to remove the left hip-bone. The obturator fascia and great sacro-sciatic ligament are first to be detached, and then the bone is to be sawn through, about three-quarters of an inch outside the symphysis pubis in front, and at the articulation with the sacrum behind. After the bone has been pulled somewhat away from the rest of the pelvis, the ischial spine, with the recto-vesical fascia attached to it, may be cut off with a bone-forceps; and the loose piece of the hip-bone may then be removed by cutting through the fibres of the iliacus and pyriformis muscles, and any other structure that may retain it.

To remove hip-bone: detach fascia, saw bone, and divide soft parts.

A block is afterwards to be placed beneath the pelvis. The bladder is to be moderately distended with air through the ureter, and the urethra is to be tied. Some tow is to be introduced into the rectum, also into the vagina if it is a female pelvis; and a small piece is to be placed in the pouch of peritoneum between the bladder and the rectum. After the viscera are thus made prominent without distension, the ischial spine and the recto-vesical fascia should be raised with hooks, while the levator ani (D) and coccygeus (C) muscles below it are cleaned.

Then blow up bladder and distend other parts.

PARTS CLOSING THE PELVIS BELOW. In addition to the recto-vesical fascia, the following parts close the pelvic cavity on each side, between the sacrum and the pubic symphysis.

Outlet of pelvis is closed by

Behind, the student will meet with the pyriformis passing through the great sacro-sciatic foramen, with the gluteal vessels and nerve (fig. 142, *g a* and *s g n*) above it. Next comes the coccygeus muscle (fig. 143, C) on the small sacro-sciatic ligament, between the ischial spine and the coccyx; one border of this muscle is contiguous to the pyriformis, the other to the levator ani: and between its upper border and the pyriformis lie the great sciatic and pudic nerves, with some other branches of the sacral plexus, and the sciatic and pudic vessels. The greater part of the pelvic outlet is closed by the levator ani (D), which extends forwards from the coccygeus to the symphysis pubis. It meets its fellow behind, but the muscles of opposite sides are separated in front by the urethra, with the vagina in the female; and the interval between them in front is closed by the triangular ligament of the perineum (H).

pyriformis, by coccygeus and sacro-sciatic ligament, with vessel and nerves, by levator ani, and by triangular ligament.

The COCCYGEUS MUSCLE (fig. 143, C) is flat and triangular, and has much tendinous substance mixed with its fibres. It *arises* from the upper part of the inner surface of the ischial spine (fig. 139, p. 369), and some fibres are attached to the adjoining part of the obturator fascia. Widening as it passes inwards, the muscle is *inserted* into the side, and the contiguous anterior surface of the coccyx, and into the side of the lowest piece of the sacrum.

Coccygeus: origin; insertion;

The inner surface looks to the pelvis, and is in contact with the

relations of surfaces

rectum : the opposite surface is in great part covered by the small sacro-sciatic ligament, to which it is closely united. The upper
and borders; border is contiguous to the pyriformis muscle, vessels and nerves intervening ; and the lower meets the levator ani.

use. *Action.* This muscle helps the levator ani in supporting and raising the floor of the pelvis : it may also draw the coccyx slightly forwards.

Levator ani: The LEVATOR ANI (fig. 143, D, also fig. 92, p. 241) is a thin flat muscle, which is attached above to the side of the pelvis, and descends into the outlet of the cavity, where it joins its fellow and
situation; supports the viscera.

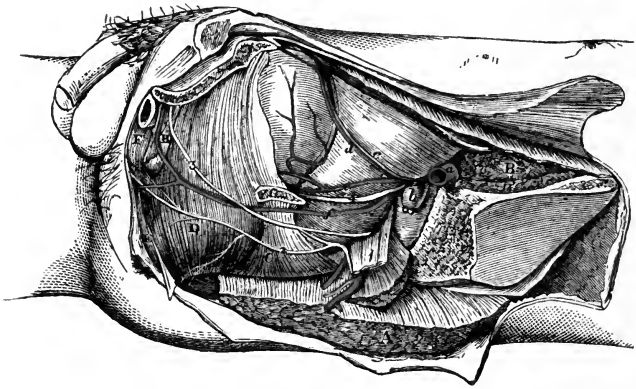


FIG. 143.—SIDE VIEW OF THE MUSCLES IN THE OUTLET OF THE PELVIS (ILLUSTRATIONS OF DISSECTIONS).

Muscles :

A. Gluteus maximus, cut.
B. Ilio-psoas, cut.
C. Coccygeus.
D. Levator ani.
E. External sphincter.
F. Ejaculator urinæ.
G. Ischial spine, cut off.
H. Triangular ligament.

Arteries :

a. External iliac artery, cut.
b. External iliac vein, cut.
c. Obliterated hypogastric.
d. Upper, and *e*, lower vesical.
f. Internal pudic.

Nerves :

1. Great sciatic.
2. Inferior hæmorrhoidal and perineal of pudic.
3. Dorsal nerve of penis.

origin from pubis, It *arises* anteriorly by tendinous fasciculi from the back of the pubis along an oblique line in front of the obturator internus (fig. 139); and below this some fleshy fibres often spring from the upper surface of
triangular ligament, the triangular ligament. Posteriorly it is attached to the lower and
ischial spine, inner part of the ischial spine (fig. 139) ; and between these osseous
and pelvic fascia; attachments the muscle takes origin in the angle between the obturator and recto-vesical portions of the pelvic fascia (along the curved line * * in fig. 142). From this wide origin the fibres converge, the anterior being directed backwards, and the posterior downwards
insertion into central point of perineum, and inwards, to be *inserted* in the following manner :—The most

anterior fibres, few in number, join with the muscle of the opposite side in the central point of the perineum; the succeeding fibres, which arise from the pubis, are the longest, and pass backwards over the prostate to the side of the rectum, where they mix to a small extent with the fibres of the sphincter muscles, but most of them are continued to the tip of the coccyx (*pubo-coccygeus*); and the posterior fibres meet the opposite muscle in a narrow aponeurosis behind the gut, and are attached in part to the side of the coccyx (*ischio-coccygeus*).

rectum,

a median aponeurosis, and coccyx;

The anterior fibres of the levator are in contact with the triangular ligament; and there is an interval between the two muscles which allows the urethra, with the vagina in the female, to pass from the pelvis. The posterior border is adjacent to the coccygeus muscle. The upper surface is in contact with the recto-vesical fascia; and the under surface looks to the ischio-rectal fossa, and is covered by the thin anal fascia.

relations of borders,

and surfaces;

Action. The levatores ani acting together support and raise the floor of the pelvis, and compress the pelvic viscera. They are used in expelling the contents of the organs, and, in forcible expiratory efforts, they act in conjunction with the muscles of the abdominal wall. At the end of defæcation, they empty the lower part of the rectum, compressing it from behind forwards; and the lower fibres assist in closing the anal passage. The levatores ani and coccygei muscles form a fleshy layer or *pelvic diaphragm* across the outlet of the pelvis, similar to that which separates the abdomen from the chest: this partition is convex below and concave above, and gives passage to the rectum.

use,

on pelvic floor,

on cavity of abdomen,

on rectum.

Pelvic diaphragm.

Dissection. The recto-vesical fascia will now be seen by detaching the fibres of the levator ani and the coccygeus at their origin, and throwing both downwards. The thin membrane descends above the levator ani to the side of the bladder and the rectum, and sends downwards sheaths round the prostate and the gut. To demonstrate those sheaths, one incision is to be made along the prostate, and another along the lower end of the rectum, below the attachment of the fascia; and the sheaths are to be separated from the viscera.

Dissection for recto-vesical fascia.

The RECTO-VESICAL FASCIA supports and partly invests the viscera of the pelvis. Covering the pelvic surface of the levator ani, it is fixed above, like that muscle, to the pubis in front, and to the obturator fascia at the side; while behind, it is continued over the coccygeus muscle into the fascia of the pyriformis. Below, it meets the fascia of the opposite side in the centre of the pelvis, and forms a partition across the cavity, like that of the levator ani, which is perforated by the bladder and the rectum. The partition is strengthened on each side by a thicker band (the so-called *white line of the pelvic fascia*) stretching from the pubis to the ischial spine. It is concave above and convex below, and divides the cavity of the pelvis from the perineal space. This septum is attached to the viscera which pierce it, forming ligaments for them: and from the under surface sheaths are prolonged on the rectum and the prostate.

Recto-vesical fascia:

attachments;

forms the floor of the pelvis;

supports viscera;

prolongations are,

sheath on the rectum,

The sheath on the rectum encloses the lower three inches of the intestine, and gradually becomes very thin towards the anus; it is separated from the intestine by a layer of fat.

and on prostate.

On the prostate the sheath is thinner than on the rectum, and very closely adherent; it is continued downwards to the apex of that body, where it passes into the upper layer of the triangular ligament of the urethra: between it and the proper investing capsule of the prostate are the *prostate plexus of veins* and some small arteries.

The prostate plexus.

Fascia in the female.

In the female the fascia has much the same arrangement as in the male; but the vagina perforates the membrane, and receives a tube from it, like the prostate.

Ligaments of the fascia;

The *true ligaments of the bladder* are two on each side, anterior and lateral, and are portions of the recto-vesical fascia.

anterior ligaments,

The *anterior* (or *pubo-prostatic*) reaches from the back of the pubis to the fore part of the prostate and the neck of the bladder; it is a narrow white band, and encloses muscular fibres of the bladder.

and lateral of the bladder;

The *lateral ligament* is the side piece of the fascia, which is fixed to the upper border of the prostate gland, and to the side of the bladder close above the vesicula seminalis; from it an offset is continued inwards behind the vesicula seminalis, so as to join a like piece from the other side, and form a sheath for those bodies.

ligament of rectum.

On each side of the rectum is a strong wide piece of the recto-vesical fascia, which is attached externally to the ischial spine of the hip-bone, and supports that viscus like the bladder.

RELATIONS OF THE VISCERA IN THE MALE.

Directions. If the student dissects a female pelvis, he will pass on to page 390 referring to this section for the description of the rectum, bladder and other parts.

Contents of the pelvis,

Contents and position (figs. 144 and 145). The viscera of the male pelvis are—the rectum, the bladder with the prostate and first part of the urethra, the lower ends of the ureters, parts of the vasa deferentia, and the vesiculæ seminales.

and outline of their position.

The rectum (fig. 145, *k*) lies at the back of the pelvis, and takes a curved course in the hollow of the sacrum and coccyx, round the end of which it bends backwards as the *anal canal* (Symington). The bladder (*a*) is placed in the concavity of the rectum, its neck being surrounded by the prostate gland (*b*); and the urethra, after perforating the prostate, curves forwards to the penis. The ureter (*h*) descends by the side of the rectum to the *lateral angle* at the hinder part of the bladder on each side; and the vas deferens (*f*) and vesicula seminalis (*g*) are between the bladder and rectum on each side. Some of these organs are partly invested by peritoneum, as already described.

Take away fascia, and clean vessels.

Dissection. All the recto-vesical fascia, except the anterior true ligament of the bladder, may be taken from the prostate and rectum. The obliterated hypogastric cord from the internal iliac artery should be followed forwards along the bladder from the back of the pelvis; and the branches of the same artery to the bladder should

be cleaned. When the fat has been cleared from the rectum, without injuring its arteries, the pouch of the peritoneum, in which tow

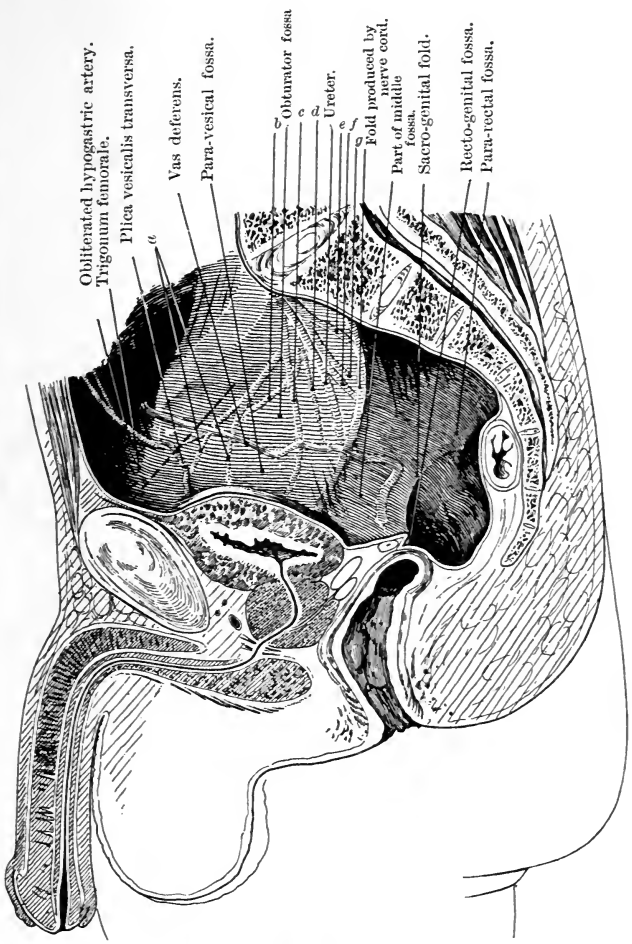


Fig. 144.—Vertical Section of a Male Pelvis (Dixon and Birmingham). (From the Journal of Anatomy and Physiology, Vol. 36.)

a. Vesical arteries.
b. Obturator artery.
c. Inferior vesical artery.
d. Mid. hæmorrhoidal artery.
e. Gluteal artery.
f. Int. pudic artery.
g. Sciatic artery.

has been placed, will be brought into view, with the ureter passing to the bladder across its side.

The bladder below the peritoneum is to be cleaned; and the vas deferens is to be followed down to the seminal sac. Take away

The several viscera are to be cleaned.

with care the remains of the sheath of the vesicula seminalis, defining at the same time the vas deferens internal to the latter.

Rectum; extent and length;

The RECTUM, or last part of the great intestine (figs. 144 and 145, *k*), extends from the third piece of the sacrum at the termination of the pelvic colon to a little more than an inch in front of the tip of the coccyx where it bends downwards and backwards as the anal canal. It is about five inches in length. The bowel follows the curve of the sacrum and the coccyx, and is supported mainly by the peritoneum, the recto-vesical fascia, and the perineal muscles.

course and supports;

Covered by peritoneum;

It lies behind the bladder, and is covered by peritoneum in front

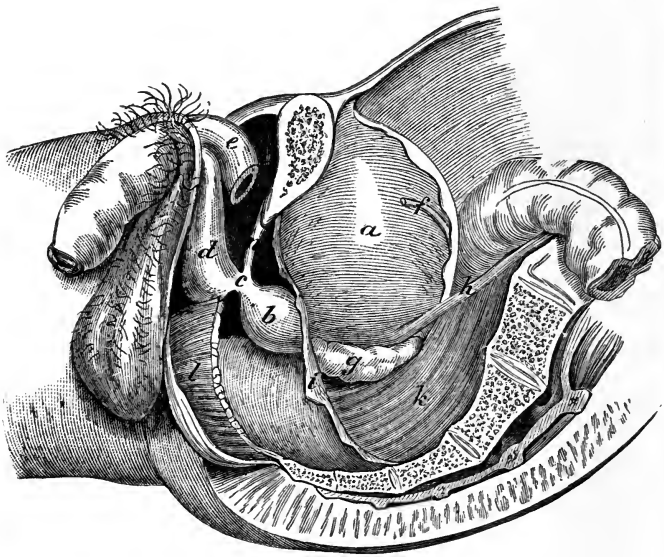


FIG. 145.—SIDE VIEW OF THE DISSECTED MALE PELVIS.

a. Urinary bladder partly filled.
b. Prostate.
c. Membranous part of the urethra.
d. Spongy part of the urethra.
e. Crus penis, divided.
f. Vas deferens.
g. Vesicula seminalis.
h. Ureter.
i. Recto-vesical fascia.
k. Rectum.
l. Levator ani, cut.

for about the upper two-thirds of its extent, and on the sides for its upper third only (p. 376). Immediately below this it pierces the recto-vesical fascia, and receives its sheath from that membrane.

relations.

Resting on it is the triangular base of the bladder, with the vesiculæ seminales and vasa deferentia; and beneath it are the sacrum and coccyx. On each side is the coccygeus muscle.

Part not covered by peritoneum;

After the peritoneum leaves it, the rectum is directed downwards and forwards from the end of the coccyx, through the hinder part of the perineum, for a distance of about one inch and a half,

to the anal passage. This part of the bowel is supported by the triangular ligament of the urethra, and by the levatores ani and external sphincter muscles.

In front of this part are the prostate, the membranous part of the urethra, and the bulb of the corpus spongiosum urethræ. The levatores ani muscles descend on its sides, and unite beneath it, supporting it as in a sling. Sometimes the lower half of the rectum is very much enlarged, especially in women and old men ; and in that condition in the male it rises up on each side of the prostate. relations with parts around; sometimes much dilated.

The *anal passage* or *canal* (Symington) leads downwards and backwards from the lower end of the rectum to the anal opening. Its length varies from half an inch to one inch, being shorter when the bowel is distended. It is surrounded by the internal and external sphincter muscles, and is compressed laterally in the intervals between defæcation, so that its side-walls are in contact, and the lumen has the form of a median slit. Anal canal.

The URINARY BLADDER (vesica urinaria ; figs. 144 and 145, *a*) is the receptacle for the urine, and is situate in the fore part of the pelvis. Bladder is in pelvis when empty,

When the bladder is contracted it is flattened, and of a triangular form, and lies against the anterior wall of the pelvis ; but when distended it becomes rather egg-shaped, with the larger part towards the rectum, and the apex to the abdominal wall. In distension during life it is slightly curved forwards over the pubic bones, and projects above them ; and if its axis were prolonged forwards and backwards, it would touch the abdominal wall a variable distance (according to the distension) above the pubic symphysis in front, and the lower end of the sacrum behind. and projects above when full. Axis.

The position and form of the bladder are not the same in early life as in the adult. In the new-born child it rises much above the brim of the pelvis into the hypogastric region of the abdomen, and has little or no basal surface, simply tapering down to the urethral orifice which is the lowest part and is opposite the upper border of the symphysis pubic (Symington). During early years the bladder rapidly sinks, but it is only after puberty that its final position is attained. At all times its anterior surface is uncovered by peritoneum. Position in the child,

In the adult the bladder is for the most part contained within the space enclosed by the pelvic bones, and the base projects backwards. in the adult.

Form. In the empty condition the bladder is somewhat flattened from above downwards, and triangular in outline, presenting an *upper* surface with a posterior border and two lateral borders converging in front at the apex or summit, a *basal* surface opposed to the rectum, and an *anterior* surface opposed to the pubic symphysis. Form.

The organ is maintained in position by the recto-vesical fascia and the peritoneum, as already described (pp. 378 and 384). The relations of the moderately full bladder are as follows :—

The *summit* or *apex* is rounded, and from it three ligamentous Apex has three cords from it.

cords are prolonged to the umbilicus; the central one of these is the urachus; and the two lateral are the obliterated hypogastric arteries (fig. 109, p. 299). All the surface behind the obliterated vessels is covered by peritoneum.

Basal surface. SURFACES. The *base* or *basal surface* rests against the middle part of the rectum. Connected with it are the vesiculæ seminales and the vasa deferentia; and between these is a *triangular space*, from which the peritoneum is mostly absent.

Anterior, The *anterior* or *pubic surface* of the body is in contact with the pubic bones and anterior true ligaments, as well as with the abdominal wall if the bladder is very full. It is altogether free from peritoneum.

superior The *superior* or *abdominal surface* is entirely covered by the serous membrane, and has the small intestine and the pelvic colon resting on it; the ureter enters its postero-lateral angle at either side, and the vas deferens courses over the hinder part of this surface beneath the peritoneum.

and lateral. Extending along the upper part of each lateral region is the obliterated hypogastric artery, which marks the extent of the peritoneal covering at the side. The surface below this is connected with the pelvic fascia by very loose areolar tissue.

Neck, The *neck* (cervix) is the part of the bladder near the urethra, and is surrounded by the prostate gland. This is the lowest part of the organ.

Condition of empty bladder. When the bladder is empty, the upper wall falls upon the lower; the apex lies at the upper end of the pubic symphysis; and the base is of very small extent and looks downwards. In a median section the cavity then appears as a slit, which is continued backwards for a short distance beyond the beginning of the urethra.

Ureter in pelvis, The URETER (figs. 144 and 145, *h*) crosses the common or the external iliac artery, and inclines forwards below the level of the obliterated hypogastric artery, being covered by the peritoneum

enters bladder. above the sacro-genital fold. It enters the bladder at the upper and outer part of the base, at the distance of one inch and a half or two inches from the prostate gland.

Prostate: position; form; axis; The PROSTATE GLAND (figs. 144 and 145, *b*) surrounds the neck of the bladder. Its shape is conical with the base turned upwards, and its size about equals that of a large chestnut. In the recumbent position, a line from the apex through the middle of the gland would be directed obliquely backwards and slightly downwards towards the sacrum; but in the erect state of the body the axis is nearly vertical.

relations of anterior surface, The *anterior surface* is about three-quarters of an inch from the symphysis pubis, to which it is attached by the anterior true ligaments of the bladder. On this surface the dorsal vein of the

posterior surface, penis divides to enter the prostatic plexus. The *posterior surface* has the greatest extent, and is close to the rectum; this is the part that is felt by the finger introduced into the bowel through the

and side; anus. On each side the prostate is covered by the levator ani.

apex and base; The *apex* rests on the upper surface of the triangular ligament;

and the *base* surrounds the neck of the bladder and the common seminal ducts.

The prostate is enveloped by a sheath obtained from the recto-vesical fascia (p. 349), and the prostatic plexus of veins surrounds it. Through the gland the urethra takes its course to the perineum; and the common seminal ducts pierce it obliquely to open into the urethra, as will be seen in the examination of the organ after its removal from the body. The size of the prostate varies much; and in old men it may acquire a considerable magnitude.

it is contained in a sheath; size may increase.

The VESICULÆ SEMINALES (fig. 145, *g*) are two small sacculated bodies, each about two inches long, between the base of the bladder and the rectum. Each is pyramidal in form, and has the larger end turned upwards towards the ureter, while the smaller touches the prostate. Along the inner side is the vas deferens. At the prostate gland the vesiculæ approach one another, only the vasa deferentia intervening; but higher up they diverge, and enclose a triangular space at the base of the bladder. The vesiculæ are contained in a membranous sheath, which is derived from the recto-vesical fascia, and is lined by involuntary muscular fibres.

Seminal vesicles: their relations, and sheath.

The VAS DEFERENS, or the excretory duct of the testis (figs. 144 and 145, *f*), in its course to the urethra enters the abdomen by the internal abdominal ring, and crossing the obliterated hypogastric artery, is directed downwards along the hinder part of the bladder to the base of the prostate, where it forms the common seminal or ejaculatory duct by joining with the duct from the vesicula seminalis. The position of this tube to the external iliac artery has been noticed; on the bladder it passes internal to the ureter and the vesicula of the same side. By the side of the vesicula the duct is much enlarged, and is sacculated.

Vas deferens: course; unites with duct from vesicula.

Dissection. The prostate being cleaned the membranous and spongy parts of the urethra will now be cleanly laid bare on the left side but not opened.

The URETHRA is the excretory passage for the urine and semen (fig. 144), and reaches from the bladder to the end of the penis. In length it measures about eight inches, and presents one or two curves according to the state of the penis. At first the canal is directed downwards and forwards through the triangular ligament of the perineum to the root of the penis, forming a large curve with the concavity to the pubis. Thence to its termination the urethra is contained in the penis; and while this body remains pendent the canal forms a second bend with the concavity downwards; but if the penis is raised the tube makes but one curve. The canal is divided into three parts—prostatic, membranous, and spongy.

Urethra: length; curves; division.

The *prostatic part* (*b*) is contained in the prostate gland. Its length is about one inch and a quarter, and in the erect posture of the body it descends nearly vertically to the triangular ligament.

Prostatic.

The *membranous part* (*c*), about three-quarters of an inch long, intervenes between the apex of the prostate and the lower surface of the triangular ligament. It slants forwards in the erect posture to the lower part of the triangular ligament; and as the bulb of

Membranous:

the next portion of the urethral tube is directed backwards below it, its under surface measures only half an inch.

relations. This portion of the urethra is the weakest; but it is supported by the triangular ligament (*n*). Surrounding it are the muscular fibres of the constrictor urethræ; and close behind it are Cowper's glands and the rectum.

Spongy. The *spongy part* (*d*) is so named from its being surrounded by a cellulo-vascular structure. It is applied to and assists to form the body of the penis, and the canal terminates anteriorly in the orifice named the *meatus urinarius* at the end of the glans. It is the longest part of the urethra, and measures about six inches. At its commencement this division of the excretory canal is covered by the ejaculator urinæ muscle.

Fixed curve of urethra: extent; The *fixed curve of the urethra* is the bend at the hinder part of the canal as it lies behind the pubis. It extends from the bladder to an inch and a half in front of the aperture in the triangular ligament, and comprises the prostatic and membranous portions,

where greatest. with a fourth of the spongy part. Its convexity, which is turned downwards and backwards, is greatest immediately below the triangular ligament in the erect posture of the body; and from this point it ascends to the bladder, but is directed nearly horizontally forwards to the penis.

Voluntary and involuntary muscles surround it. It is surrounded by voluntary and involuntary muscular fibres; thus, above the ligament, by the involuntary muscular tissue of the prostate; within the ligament by the voluntary constrictor urethræ, with a thin involuntary layer inside that muscle; and below the ligament by the voluntary ejaculator urinæ.

Size. The size of the canal is *least* where the tube lies between the layers of the ligament, except at the external urinary meatus; and it is *largest* in the middle of the prostate.

RELATIONS OF THE VISCERA IN THE FEMALE.

Contents of the female pelvis, In the pelvis of the female are contained the rectum and the bladder, with the ureters and urethra, as in the male; but there are in addition the uterus with its accessories, and the vagina.

and their situation. *Position.* The rectum is posterior to the rest as in the male pelvis, and forms a like curve. In the concavity of the bent intestine lie the uterus with its appendages, and the tube of the vagina. And in front of all are the bladder and the urethra. There are thus three tubes connected with the viscera in this sex, viz., the urethra, the vagina, and the rectum; and all are directed downwards to the surface.

The peritoneum on the uterus; The Peritoneum. The student should first master the description of the peritoneum of the pelvic cavity contained on pages 376 to 378.

In addition to what has already been described it will be noticed that whilst the peritoneum covers the whole of the back of the uterus it only passes some two-thirds of the way down its anterior surface and is then reflected on to the upper surface of the bladder without again touching the vagina.

On each side of the uterus it forms a broad fold (*broad ligament*) which attaches that organ to the wall of the pelvis.

The bladder in distension rises and occupies the shallow *utero-vesical* pouch in front of the uterus; and the deep *recto-uterine* or

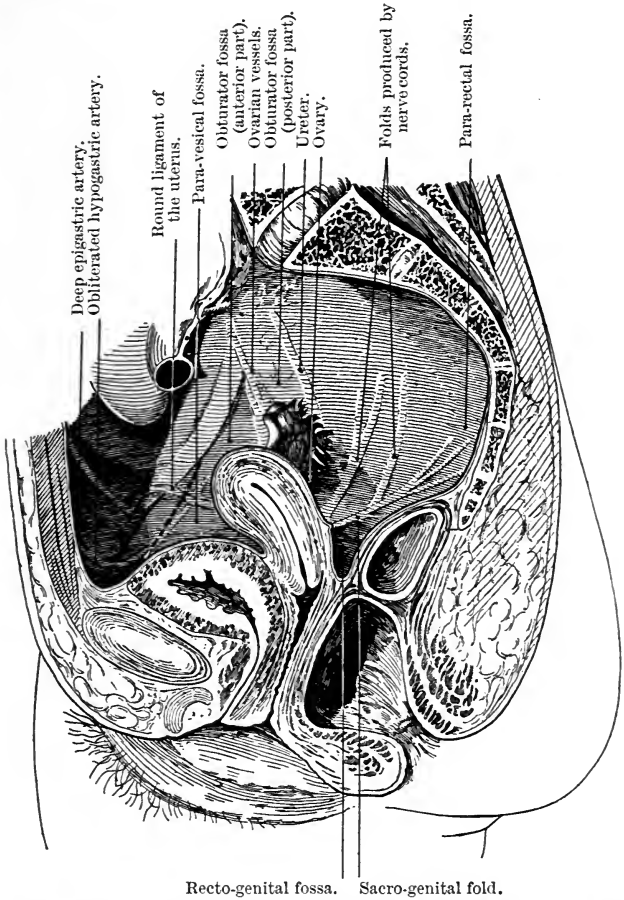


FIG. 146.—VESICAL SECTION THROUGH THE FEMALE PELVIS (DIXON AND BIRMINGHAM). (FROM THE JOURNAL OF ANATOMY AND PHYSIOLOGY, VOL. 36.)

Douglas's pouch behind is variously occupied by the pelvic colon and coils of the small intestine.

the broad ligament.

The BROAD LIGAMENT of the uterus passing from the side of the uterus to the pelvic wall completes the division of the pelvic cavity of the female into these two main parts. Along the upper border of the ligament the Fallopian tube will be noticed, and at the back, against the side wall of the pelvis, the ovary will be found. The part of the ligament below the Fallopian tube

Meso-salpenic. Meso-ovarium; ligament of the ovary; ovario-pelvic ligament; round ligament.

and above the ovary is called the *meso-salpinx* and the short fold attaching the ovary is the *meso-ovarium*. Passing from the lower and inner end of the ovary to the upper part of the uterus behind is a well-marked band—the *ligament of the ovary;* and a fold containing the ovarian vessels will be seen connecting the ovary to the pelvic wall over the external iliac artery; this is the *ovario-pelvic ligament*, or the suspensory ligament of the ovary.

Finally in front of the broad ligament a fibrous cord—the *round ligament of the uterus*—can be traced from the uterus over the pelvic brim to the internal abdominal ring.

The *false ligaments of the bladder* are substantially the same as in the male (p. 378). The so-called posterior false ligament is identical with the utero-vesical fold of peritoneum and contains the superior vesical vessels.

Use description of male pelvis for muscles and fasciæ.

Directions. The instructions for the removal of the hip-bone, and for the distension of the viscera, as well as for the dissection of the fascia and muscles of the pelvis given on page 378 should now be followed, and after the student has learnt the muscles and the fascia, which are nearly alike in both sexes, as described on pages 380 to 384, he will make the following special dissection of the viscera of the female pelvis.

Then clean the viscera of the female pelvis.

Dissection. On taking away the recto-vesical fascia and much fat the viscera will come into view. To maintain the position of the uterus, fasten it up with a piece of string passed through the upper end. The reflections of the peritoneum on the viscera are to be preserved; and a piece of cotton-wool is to be placed between the rectum and the uterus.

The obliterated cord of the hypogastric artery is to be followed on the bladder; and the ureter is to be traced forwards by the side of the uterus to the bladder. Afterwards the urethra, the vagina, and the rectum are to be cleaned and separated a little from one another at the lower part of the pelvis; but the arteries on the rectum are to be preserved.

Relations of the rectum,

The RECTUM is not so curved in the female as in the male, and is generally larger. Descending along the front of the sacrum and coccyx to the anus, its relations are similar to those of the rectum in the male (p. 386).

It reaches an inch and a half in front of the tip of the coccyx, and has the vagina in front, and in contact with it; the connection between the two being considerably stronger below than above.

and anal canal.

Inferiorly it ends in the *anal canal*, which inclines backwards, away from the vagina so as to leave between the two a space which corresponds, on the surface of the body, with the perineum between the anus and the vulva. The levatores ani are on the sides, and unite behind the rectum in front of the coccyx, and the sphincter muscles surround the anal passage as in the male.

Uterus: form and situation;

The UTERUS (fig. 146 and fig. 147, o) is rather pyriform in shape, and flattened from before backwards. Unless enlarged, it lies below the brim of the pelvis, between the bladder and the rectum; and it is supported by its ligaments. Its wider end is free and

placed upwards; and the lower end communicates with the vagina.

The axis of the uterus may be said to correspond generally with that of the inlet of the pelvis; but the position of the organ is subject to considerable variation, and is especially influenced by the state of the bladder. The fundus is commonly directed forwards, and the anterior surface rests against the bladder; but sometimes the organ is more upright, or even inclined backwards, and then the small intestine descends into the vesico-uterine pouch. position and direction vary;

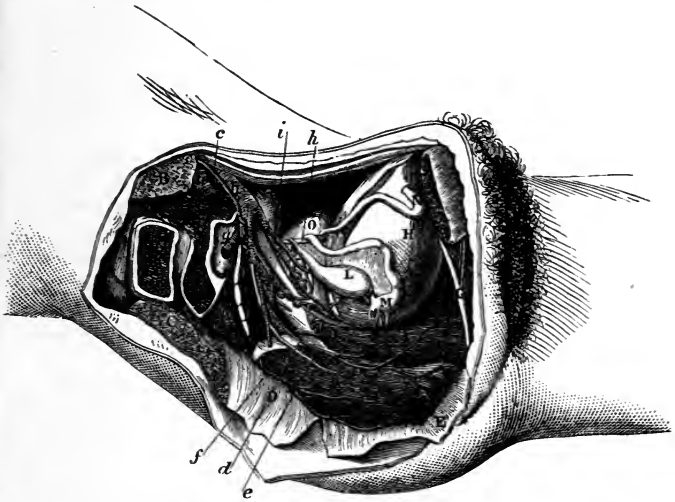


FIG. 147.—SIDE VIEW OF THE FEMALE PELVIS (ILLUSTRATIONS OF DISSECTIONS).

Muscles and Viscera:

A. Pyriformis muscle, cut.
B. Large psoas, cut.
C. Gluteus maximus, cut.
D. Coccygeus, and E, levator ani, thrown down.
F. Sphincter vaginæ.
G. Urethra.
H. Urinary bladder.
I. Vagina.
K. Rectum.
L. Ovary and its ligament.
M. Fallopian tube.
N. Round ligament.
O. Uterus.

Arteries:

a. External iliac.
b. Internal iliac.
c. Ovarian.
d. Uterine.
e. Vaginal.
f. Upper hæmorrhoidal.
g. Gluteal, cut.
h. Obliterated hypogastric.
i. Vesical.

The *anterior surface*, somewhat flattened, is covered by peritoneum, except in the lower third where it is in contact with the bladder. The *posterior surface* is rounded and is invested altogether by the serous membrane. relations of surfaces,

The *upper end* or *fundus* is the largest part of the organ and is in contact with the small intestine. The *lower end* or *neck* (cervix) is received into the vagina. extremities

and side. To each *side* are attached the broad ligament with the Fallopian tube, the round ligament, and the ovary.

Round ligament. The *round* or *suspensory ligament* (N) is a fibrous cord about five inches long which is directed forwards and outwards to the internal abdominal ring, and then through the inguinal canal to end in the groin (see p. 277). This cord lies over the obliterated hypogastric, and the external iliac artery; and it is surrounded by the peritoneum, which accompanies it a short way into the canal.

Fallopian tube. The FALLOPIAN TUBE (M), about four inches long, is contained in the upper or free border of the broad ligament. One end is connected to the uterus close to the fundus, while the other is folded round the ovary. At the uterine end the tube is of small size, but at the opposite extremity it is dilated like a trumpet, and fringed (fig. 146), forming the *corpus fimbriatum:* one of the fimbriæ is attached to the upper part of the ovary.

Ovary, The OVARY (L) is oval in form, but rather flattened, and very variable in size. It forms a projection at the back of the broad ligament, and is invested by the peritoneum except along one (the attached) border. In the natural condition it lies nearly vertically against the side wall of the pelvis, and is embraced by the outer part of the Fallopian tube: the direction of its free border varies. Its lower end, which is directed somewhat forwards, is attached to the uterus by the special fibrous band already noticed, about one inch and a half in length, the *ligament of the ovary.*

and its ligament.

Vagina: extent and form; The VAGINA (fig. 146 and fig. 147, I) is the tube by which the uterus communicates with the exterior of the body. It is compressed from before backwards, being slit-like in section from side to side; and its length is about three inches. As it follows the bend of the rectum, it is slightly curved; and its axis corresponds below with that of the outlet, but higher up with that of the cavity of the pelvis.

length; axis;

relations. In front of the vagina are the base of the bladder, and the urethra; and behind it is the rectum, but the peritoneum intervenes between the two for a short distance at the upper end. It is transmitted through an opening in the recto-vesical fascia, which sends a sheath along the lower half of the tube; and the levator ani lies along the side external to this. The upper end receives the neck of the uterus by an aperture in the anterior wall; and the lower end, the narrowest part of the canal, is encircled by the sphincter vaginæ muscle. A large plexus of veins surrounds the vagina within its sheath. In children, and in the virgin, the external aperture is partly closed by the hymen (p. 255).

Bladder The BLADDER (fig. 146 and fig. 147, H) is placed at the fore part of the pelvis, in front of the vagina, and in contact with the back of the pubic bones. Its positions and relations so closely resemble those of the bladder in the male body, as to render unnecessary a separate description of them (p. 387). The chief differences in the bladder of the two sexes are the following:—

resembles that of the male;

differences in the two sexes. In the female the bladder is more globular than in the male, and the transverse often exceeds the longitudinal measurement.

The base is of less extent, and is in contact with the vagina and the neck of the uterus. The vasa deferentia, vesiculæ seminales and prostate are absent.

The URETER has a longer course in the female than in the male pelvis before it reaches the bladder. After crossing the internal iliac vessels, it passes by the neck of the uterus to its destination. Course of ureter.

The URETHRA (fig. 146 and fig. 147, G) is about one inch and a half long, and by its position corresponds to the prostatic and membranous portions of the male passage, although it represents only the upper half of the prostatic urethra. It is situate in front of the vagina, and describes a slight curve, with the concavity forwards, below the symphysis pubis. Its external opening (*meatus urinarius*) is placed within the vulva (p. 255). Urethra: length; position and course;

In its course to the surface it is embedded in the tissue of the vagina wall, and perforates the triangular ligament of the perineum, where it is surrounded by fibres of the deep transverse muscle, and a layer of circular involuntary fibres (p. 258). A plexus of veins surrounds the urethra as well as the vagina. relations.

VESSELS AND NERVES OF THE PELVIS.

In the pelvis are contained the internal iliac vessels and their branches to the viscera, the sacral plexus of nerves, and the sympathetic nerve. This section is to be used by the dissectors of both the male and female pelvis. Vessels and nerves of the pelvis.

Directions. The internal iliac vessels are to be dissected on the right side. The air should be previously let out of the bladder; and this viscus and the rectum, with the uterus and the vagina in the female, should be drawn aside from their situation in the centre of the pelvis (fig. 148).

Dissection. The loose tissue and fat are to be removed from the trunk of the vessels, as well as from the branches of the arteries that leave the pelvis, or supply the viscera; and the cord of the obliterated hypogastric artery is to be traced on the bladder to the umbilicus. To dissect the vessels of the pelvis,

With the vessels are offsets of the hypogastric plexus of nerves, though these will probably not be seen; but in dissecting the vessels to the bladder and rectum, visceral branches of the sacral spinal nerves will now come into view. The veins may be removed in a general dissection. nerves, veins.

When the vessels have been prepared the bladder may again be distended, and the viscera replaced.

The INTERNAL ILIAC ARTERY (fig. 148, *g*, p. 397) is one of the trunks resulting from the division of the common iliac artery, and furnishes branches to the viscera and wall of the pelvis, to the organs of generation, and to the limb. Internal iliac artery:

In the adult the vessel is a short trunk of large capacity, which measures from an inch to an inch and a half in length. Directed downwards towards the great sacro-sciatic foramen, the artery terminates generally in two divisions (anterior and posterior), from which size and length; termination;

the several offsets are furnished. From the extremity a partly obliterated vessel (hypogastric) extends forwards on the bladder.

relations; The artery is covered by the peritoneum, and the ureter crosses its upper end obliquely on the inner side. It lies on the sacrum

position of vein; and the lumbo-sacral cord. It is accompanied by the internal iliac vein, which is posterior to it, and somewhat to its inner side.

branches. The *branches* of the artery are numerous, and arise usually in the following manner:

From the *posterior division:*
1. Ilio-lumbar.
2. Upper lateral sacral.
3. Lower lateral sacral.
4. Gluteal.

From the *anterior division:*
1. Superior vesical.
2. Inferior vesical (vaginal in the female).
3. Obturator.
4. Middle hæmorrhoidal.
5. Uterine (in the female).
6. Sciatic.
7. Internal pudic.

Artery in the fœtus, *Artery in the fœtus.* In the fœtus the *hypogastric artery* takes the place of the internal iliac, and leaves the abdomen by the umbilicus. At that time it is larger than the external iliac artery; and, entering but slightly into the cavity of the pelvis, it is directed

on the bladder, forwards to the bladder, and along the side of that viscus to its apex.

and beyond; Beyond the bladder the artery ascends along the posterior aspect of the abdominal wall with the urachus, converging to its fellow. Finally, at the umbilicus, the vessels of opposite sides come in contact with the umbilical vein, and, passing from the abdomen through the aperture at that spot, enter into the placental cord, where they receive the name *umbilical.*

branches. In the fœtus, branches similar to those in the adult are furnished by the artery, though their relative size at the two periods is very different.

Transformation into that of the adult. *Change to adult state.* When uterine life has ceased, the hypogastric artery shrinks in consequence of the arrest of the current of blood through it, and finally becomes obliterated, more or less completely, to within an inch or so of its commencement. The *part of the trunk* which is unobliterated becomes the *internal iliac;* and commonly a portion of the vessel remains pervious as far as the bladder, forming the early part of the *superior vesical artery.*

Trunk often varies in length, *Peculiarities.* The *length* of the internal iliac artery varies from half an inch to three inches, its extreme measurements; but in two-thirds of a large number of bodies it ranged from an inch to an inch and a half (R. Quain).

rarely in size. *Size.* In the rare cases where the femoral trunk is derived from the internal iliac, and is placed at the back of the thigh, this vessel is larger than the external iliac.

Branches of the posterior part. A. The BRANCHES arising from the posterior division of the internal iliac may be first examined.

Ilio-lumbar has an The *ilio-lumbar artery* (fig. 148, *h*) passes outwards beneath the

psoas muscle and the obturator nerve, but in front of the lumbo-sacral cord, and divides into an ascending and a transverse branch :—

The *ascending* or *lumbar branch* runs beneath the psoas ; it supplies that muscle and the quadratus lumborum, anastomoses with the last lumbar artery, and sends a small *spinal branch* through the foramen between the sacrum and the last lumbar vertebra. ascending and

The *transverse* or *iliac branch* divides into offsets that ramify in a transverse branch.

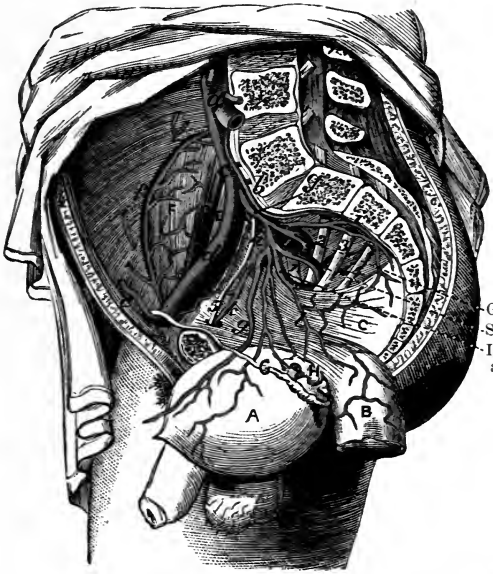


FIG. 148.—THE INTERNAL ILIAC ARTERY (TIEDEMANN).

A. Bladder.
B. Lower end of the rectum.
C. Levator ani.
D. Psoas magnus.
E. Psoas parvus.
F. Iliacus.
G. Vas deferens.
H. Vesicula seminalis.

Arteries :

a. Aorta splitting into the common iliacs.
b. Middle sacral.
c. Common iliac.
d. External iliac.
e. Deep epigastric.
f. Deep circumflex iliac.
g. Internal iliac, continued by an impervious cord along the bladder.
h. Ilio-lumbar.
i. Lateral sacral.
k. Obturator.
l. Middle hæmorrhoidal.

Nerves :

1. Lumbo-sacral cord.
2, 3, 4. Upper three sacral nerves.
5. Obturator.

the iliacus muscle, some running over and some beneath it. At the iliac crest these branches anastomose with the lumbar and deep circumflex iliac arteries ; some deep twigs communicate with the obturator artery, and enter the hip-bone.

The *ilio-lumbar vein* opens into the common iliac trunk.

The *lateral sacral arteries* (fig. 148, *i*) are usually two in number, Lateral sacral arteries

superior and inferior: they correspond in situation with the lumbar arteries, and form a chain of anastomoses by the side of the apertures in the sacrum. These arteries supply the pyriformis and coccygeus muscles, and anastomose with each other, as well as with the middle sacral. A *spinal branch* enters each aperture in the sacrum.

supply spinal branches.

Gluteal artery:

The *gluteal artery* (fig. 148, *m*) is the continuation of the posterior division of the internal iliac, and is destined for the gluteal muscles on the outer surface of the hip-bone. It is a short, thick trunk, which leaves the pelvis through the great sacro-sciatic foramen above the pyriformis muscle, with its accompanying vein and the superior gluteal nerve, passing between the lumbo-sacral cord and the anterior division of the first sacral nerve, or sometimes between the anterior divisions of the first and second sacral nerves, as in fig. 148. In the pelvis the artery gives small *branches* to the contiguous muscles, viz., iliacus, pyriformis, and obturator, and a twig to the hip-bone.

small offsets.

Branches of anterior part.

B. The BRANCHES *of the anterior division* of the internal iliac artery are the following :—

Upper vesical.

The *superior vesical artery* is the imperfectly obliterated portion of the fœtal hypogastric artery. It divides into three or four branches, which ramify over the apex and body of the bladder: the lowest of these is sometimes called the *middle vesical branch.*

Lower vesical

The *inferior vesical artery* often arises in common with the branch to the rectum. It is distributed to the base of the bladder, the vesiculæ seminales, and the prostate. A small offset from this artery, or from the upper vesical, is furnished to the vas deferens, and is known as the *artery of the vas deferens.*

or vaginal.

The *vaginal artery* (fig. 147, *e*) of the female takes the place of the inferior vesical of the male. It descends on the vagina, and ramifies in its wall as low as the outer orifice; while, superiorly, it communicates with the lower branches of the uterine artery. This branch is often given off by the uterine artery.

Middle hæmorrhoidal.

The *middle hæmorrhoidal artery* (fig. 148, *l*) commonly arises from the inferior vesical (or vaginal), or from the pudic trunk. It is spent on the anterior and lower part of the rectum, and anastomoses with the other hæmorrhoidal arteries.

Hypogastric trunk.

The preceding arteries sometimes arise in common with the superior vesical, and the trunk of origin is termed the *hypogastric trunk.*

Obturator artery courses across pelvis:

The *obturator artery* (fig. 148, *k*) is directed forwards below the brim of the pelvis to the aperture at the top of the thyroid foramen; passing through that opening it ends in two branches, which ramify on the membrane closing the thyroid foramen, beneath the obturator externus muscle. In the pelvis the artery has its companion nerve above, and vein below it; and it there gives rise to :—

offsets in pelvis;

iliac branch,

An *iliac branch* which enters the iliac fossa to supply the bone and the iliacus muscle, and anastomoses with the ilio-lumbar artery.

pubic branch.

A *pubic branch* (fig. 107, *f*, p. 294) ascends on the posterior aspect of the pubis, and communicates with the corresponding

branch of the opposite side, and with an offset from the epigastric artery.

Sometimes the obturator takes origin from the deep epigastric, as explained on p. 284, or from the external iliac artery.

The *sciatic artery* (fig. 148, *n*) is the largest branch of the anterior division of the internal iliac, and is continued over the pyriformis muscle and the sacral plexus to the lower part of the great sacro-sciatic foramen, where it issues between the pyriformis and the coccygeus muscles. Outside the pelvis it divides into branches beneath the gluteus maximus, and is distributed to the buttock : in the pelvis it supplies the pyriformis and coccygeus muscles. Sciatic artery in the pelvis, and outside it.

The *internal pudic artery* (fig. 148, *o*) supplies the perineum and the genital organs, and has nearly the same relations in the pelvis as the sciatic. It accompanies the sciatic artery, though external to it, and leaves the pelvis between the pyriformis and coccygeus. At the back of the pelvis it winds over the ischial spine of the hip-bone, and enters the perineal space, where it has already been examined. The artery gives some unimportant offsets in the pelvis, and frequently the middle hæmorrhoidal branch arises from it. Pudic artery in the pelvis: some small offsets.

Accessory pudic (R. Quain). The pudic artery is sometimes smaller than usual, and fails to supply some of its ordinary perineal branches, especially the terminal one to the penis. In those cases the deficient branches are derived from an accessory artery, which takes origin from the internal iliac (mostly from the trunk of the pudic), and courses forwards on the side of the bladder and the prostate gland, to perforate the triangular ligament. It furnishes branches to the penis to supply the place of those that are wanting. An accessory pudic branch.

The *uterine artery* (fig. 147, *d*) passes inwards between the layers of the broad ligament to the neck of the uterus, where the vessel changes its direction, and ascends in a tortuous manner along the side of the uterus up to the fundus. Numerous branches enter the substance of the uterus, and ramifying in it, are remarkable for their tortuous condition. At the neck of the uterus some small twigs are supplied to the upper part of the vagina and to the bladder, communicating with branches of the vaginal artery. At the fundus of the uterus some branches proceed outward along the Fallopian tube and anastomose with the ovarian artery from the aorta. A branch also proceeds from the upper part of the uterus along the round ligament. Uterine artery: offsets to vagina; joins ovarian.

The INTERNAL ILIAC VEIN receives the blood from the wall of the pelvis, and the pelvic viscera, by branches corresponding for the most part with those of the artery. The vein is a short thick trunk, which is situate at the posterior and inner aspect of the artery ; and it ends by uniting with the external iliac to form the common iliac vein. Internal iliac vein: position to its artery; ending;

Tributaries. Most of the vessels entering the trunk of the internal iliac vein have the same anatomy as the arteries ; but the following branches,—the pudic and the dorsal vein of the penis, the vesical and hæmorrhoidal, the uterine and vaginal, have some peculiarities. its branches that are peculiar are

pudic,

The *pudic veins* receive roots corresponding with the branches of the pudic artery in the perineum, but not those corresponding with the offsets of the artery on the dorsum of the penis.

dorsal vein of penis,

The *dorsal vein of the penis* receives veins from the corpora cavernosa and corpus spongiosum of the penis, and entering the pelvis below the symphysis pubis, divides into two, a right and a left branch, which join a large plexus round the prostate (*prostatic plexus*).

hæmorrhoidal,

The *middle hæmorrhoidal vein* communicates with a large plexus (hæmorrhoidal) around the lower end of the rectum beneath the mucous membrane.

vesical,

The *vesical veins* begin in a plexus about the fundus of the bladder, and anastomose with the prostatic and hæmorrhoidal veins.

uterine, and

The *uterine veins* are numerous, and form a plexus in and by the side of the uterus: this plexus inosculates above with the ovarian plexus, and below with one on the vagina.

vaginal veins.

The *vaginal veins* surround their tube with a large vascular plexus communicating with the veins of the bulb of the vestibule below and with the uterine plexus above.

Other arteries in the pelvis.

The arteries in the pelvis, which are not derived from the internal iliac, are the ovarian, superior hæmorrhoidal, and middle sacral.

Ovarian artery: offsets.

The OVARIAN ARTERY (p. 365), after passing the brim of the pelvis in the ovario-pelvic ligament, becomes tortuous, and enters the broad ligament to be distributed to the ovary: it supplies an offset to the Fallopian tube, and another to the round ligament; and a large branch anastomoses internally with the uterine artery.

Superior hæmorrhoidal

The SUPERIOR HÆMORRHOIDAL ARTERY, the continuation behind the rectum of the inferior mesenteric (p. 318), divides into two branches near the middle of the sacrum. From the point of division the branches are continued along the rectum, one on each side, and each ends in about three branches, which pierce the muscular layer of the gut three inches from the anus; they terminate opposite the internal sphincter in anastomotic loops beneath the mucous membrane, and anastomose with the middle and inferior hæmorrhoidal arteries.

ends in loops.

Middle sacral, which has lateral offsets.

The MIDDLE SACRAL ARTERY arises from the back of the aorta just before its bifurcation (fig. 148, *b*) and descends along the middle of the last lumbar vertebra, the sacrum, and the coccyx. The artery gives small branches laterally, opposite each piece of the sacrum, to anastomose with the lateral sacral arteries, and to supply the nerves, and the bones with the periosteum. Sometimes a small branch is furnished by it to the lower end of the rectum, to take the place of the middle hæmorrhoidal artery.

The *middle sacral veins* end in the left common iliac.

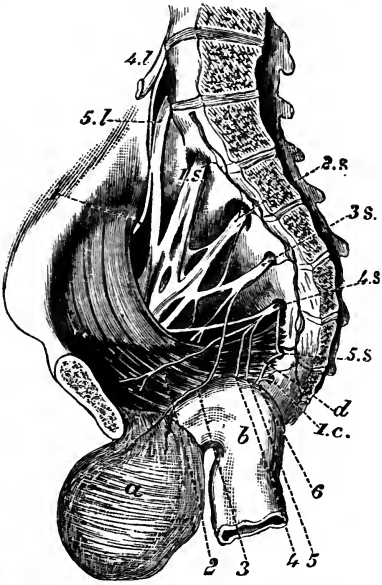
Dissection of the nerves of the pelvis

Dissection (fig. 149, p. 401). To dissect the nerves of the pelvis, on the right side, it will be necessary to detach the triangular ligament with the urethra from the bone; and to cut through, on the right side, the fore part of the recto-vesical fascia and levator ani, together with the visceral arteries, in order that

the viscera may be drawn from the side of the pelvis. If the bladder is still distended, let the air escape from it.

By means of the foregoing dissection the sacral nerves may be found as they issue from the sacral foramina. The dissector should follow the first four into the sacral plexus, and some branches from the third and fourth to the viscera. The last sacral and the coccygeal nerve are of small size, and will be detected coming through the coccygeus muscle, close to the coccyx: these are to be dissected with care; and the student will succeed best by tracing the connecting filaments which pass from one to another, beginning above with the offset from the fourth nerve.

first four sacral,



last and coccygeal,

sympathetic.

FIG. 149.—THE SACRAL NERVES AND PLEXUS (ALTERED FROM HENLE).

a. Urinary bladder.
b. Rectum.
c. Levator ani.
d. Coccygeus.

Nerves:

4 *l* and 5 *l*. Fourth and fifth lumbar nerves, giving rise to the lumbo-sacral cord.
1 *S* to 5 *S*. Five sacral nerves.
1 *c*. Coccygeal nerve.
1. Upper gluteal nerve.
2. Branch to levator ani.
3. Branch to the bladder.
4. Branch to coccygeus.
5. Branch to the perineum.
6. Common branch of 4 *S*, 5 *S*, and 1 *c*, for the back of the coccyx.

Sacral nerves are five:

The sympathetic chain lies on the front of the sacrum, just outside the plane of section.

Opposite the lower part of the rectum, bladder, and vagina is a large plexus of the sympathetic (pelvic plexus), which sends branches to the viscera along the arteries. This plexus is generally destroyed in the previous dissection; but if any of it remains, the student may trace the offsets distributed from it, and its communicating branches with the spinal nerves.

SACRAL SPINAL NERVES (figs. 149; 150, p. 403). The anterior primary branches of the sacral nerves are five in number, and decrease rapidly in size from above downwards. Issuing by the apertures on the front of the sacrum (the fifth nerve excepted), they receive short filaments of communication from the gangliated cord of the sympathetic. The first three nerves and part of the fourth enter the sacral plexus, but the fifth ends on the back of the coccyx.

most enter plexus.

The coccygeal nerve and the peculiarities of the fourth and fifth sacral will be noticed before the plexus is described.

Fourth, The FOURTH NERVE (fig. 149, 4 *S*) sends one branch upwards to the sacral plexus, another downwards to join the fifth nerve,

which gives and distributes the following offsets to the viscera and the muscles of the floor of the pelvis :—

visceral, The *visceral branches* ([3]) supply the bladder and the vagina, and communicate with the sympathetic nerve to form the pelvic plexus. Offsets are added to them from the third sacral nerve (fig. 150, *v*).

and muscular offsets. The *muscular branches* are three in number. One rather long branch (fig. 149, [2]) enters the levator ani on the visceral aspect ; another ([4]) supplies the coccygeus ; and the third (perineal) or hæmorrhoidal branch ([5]) reaches the perineum by piercing the levator ani or coccygeus muscle, and supplies the external sphincter.

Fifth is below apertures in sacrum ; The FIFTH NERVE (5 *S*) comes forwards between the sacrum and coccyx, and receives the communicating branch from the fourth nerve ; it is then directed downwards in front of the coccygeus, where it is joined by the coccygeal nerve, and perforates that muscle, the sacro-sciatic ligament, and the gluteus maximus, to

ends on coccyx. end on the posterior surface of the coccyx.

Coccygeal nerve. The COCCYGEAL NERVE (1 *c*), after issuing by the lower aperture of the spinal canal, appears through the coccygeus muscle, and joins the fifth sacral nerve as above stated.

Sacral plexus ; SACRAL PLEXUS. This plexus is formed by the lumbo-sacral cord, the first three sacral nerves, and part of the fourth sacral. It

situation ; is situate on the pyriformis muscle, beneath the sciatic and pudic branches of the internal iliac artery ; and the nerves entering it converge towards the large sacro-sciatic foramen. Here they are

how formed ; united for the most part in a broad flat band, which, becoming

ending ; gradually narrower as it leaves the pelvis below the pyriformis, forms the great sciatic nerve. A part of the third nerve, however, and the branch of the fourth entering the plexus unite to form a lower smaller trunk—the pudic nerve ; and other branches are given off by the several nerves before their union.

and branches : *Branches.* Most of the offsets of the plexus are distributed outside the pelvis, and are met with in the dissection of the buttock (pp. 109 *et seq.*) ; of these only the origin is to be seen now. The branches of the plexus are :—

1. The great sciatic nerve.
2. The small sciatic nerve.
3. The superior gluteal nerve.
4. Inferior gluteal nerve.
5. The pudic nerve.
6. Nerve to the obturator internus and superior gemellus.
7. Nerve to the quadratus femoris and inferior gemellus.
8. Nerve to the pyriformis.
9. Perforating cutaneous nerve.

Great sciatic. *a.* The *great sciatic nerve* (fig. 150, gs) is the principal nerve of

the lower limb, and is formed by the union of four large roots from the lumbo-sacral cord and the first three sacral nerves.

b. The *superior gluteal nerve* (fig. 150, sg) arises by two roots from the back of the lumbo-sacral cord and the first sacral nerve, and leaves the pelvis with the gluteal artery above the Superior gluteal.

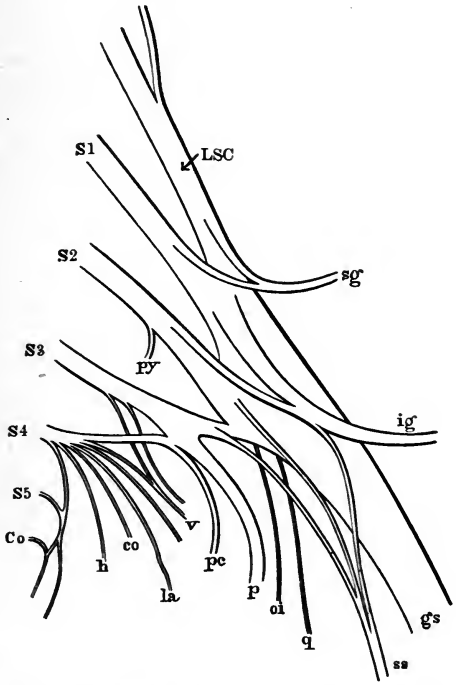


FIG. 150.—DIAGRAM OF THE SACRAL PLEXUS, FROM BEHIND.

LSC. Lumbo-sacral cord, formed by the fifth lumbar nerve and a small branch from the fourth.
SI to SV. First to fifth sacral nerves.
Co. Coccygeal nerve.
gs. Great sciatic nerve.
ss. Small sciatic.
p. Pudic.
sg. Superior gluteal.
ig. Inferior gluteal.
py. Branch to pyriformis.
oi. Nerve to obturator internus.
q. Nerve to quadratus.
v. Visceral branches of third and fourth sacral nerves.
la. Branch to levator ani.
co. Branch to coccygeus.
h. Hæmorrhoidal or perineal branch of fourth sacral.
pc. Perforating cutaneous.

pyriformis for the supply of the muscles on the outer surface of the ilium.

c. The *inferior gluteal* (ig) is the nerve of the gluteus maximus. It springs from the back of the lumbo-sacral cord and first two sacral nerves, and passes out below the pyriformis. Inferior gluteal.

d. The *small sciatic* (ss) is the cutaneous nerve of the back of the Small sciatic.

thigh, and arises before the foregoing (with which it is often connected) from the second and third sacral nerves.

Pudic. *e.* The *pudic nerve* (p) supplies the perineum and the genital organs. It arises from the third and fourth sacral nerves, and courses over the small sacro-sciatic ligament, in company with its artery, to the small sacro-sciatic foramen.

Perforating cutaneous. *f.* The *perforating cutaneous nerve* (pc) arises from the fourth, or the third and fourth, sacral nerves, and passes backwards through the great sacro-sciatic ligament to the skin of the buttock (p. 112).

Branch to pyriformis. *g.* The *branch to the pyriformis* (py) is usually given off from the second sacral nerve, and enters the anterior surface of its muscle.

Branch to obturator internus. *h.* The *nerve to the obturator internus* (oi) springs from the front of the part of the plexus formed by the union of the lumbo-sacral cord with the first sacral nerve. It leaves the pelvis with the pudic artery, and winding over the ischial spine and through the small sacro-sciatic foramen, enters the perineal surface of the muscle: it gives a branch to the superior gemellus.

Branch to quadratus. *i.* The *nerve to the quadratus femoris and inferior gemellus* (q) arises from the front of the plexus below the preceding.

Sympathetic in the pelvis. SYMPATHETIC NERVE. In the pelvis the sympathetic nerve consists of a gangliated cord, and of a plexus on each side.

The ganglated cord joins that of opposite side below in a loop; The GANGLIATED CORD (fig. 149) lies on the front of the sacrum, internal to the series of apertures in that bone. Inferiorly it converges to its fellow, and is united with it by a loop in front of the coccyx, on which there is often a median ganglion (*gang. impar*).

offsets of the ganglia, Each cord is marked by ganglia at intervals, the number varying from three to five: from them branches of communication pass outwards to the spinal nerves, and some filaments are directed inwards in front of the sacrum.

to the spinal nerves, The *connecting branches* are usually two to each ganglion, grey and white, and are very short.

The *internal branches* are small, and communicate around the middle sacral artery with the branches of the opposite side. From

to the pelvic plexus and the viscera. the first, or first two ganglia, some filaments are furnished to the pelvic plexus; and from the terminal loop offsets descend over the coccyx.

Pelvic plexuses; The PELVIC PLEXUSES (lateral inferior hypogastric) are two in number, right and left, and are continuous with the lateral prolongations of the hypogastric plexus (p. 319).

situation; Each is situate by the side of the bladder and rectum in the male, and by the side of the uterus and vagina in the female, and is joined by offsets of the

how formed: third and fourth sacral nerves. Numerous ganglia are found in the plexus, especially at the points of union of the spinal and sympathetic nerves.

offsets to the viscera of the male, viz., *Offsets.* From each plexus offsets are furnished along the branches of the internal iliac artery to the viscera of the pelvis, and the genital organs: these form secondary plexuses, and have the same name as the vessels on which they are placed.

to the rectum: The *inferior hæmorrhoidal plexus* is an offset from the back of the plexus to the rectum, and joins the sympathetic on the superior hæmorrhoidal artery.

The *vesical plexus* contains large offsets, with many white-fibred or spinal nerves, and passes forwards to the side and neck of the bladder. It gives one plexus to the vesicula seminalis, and another to the vas deferens. to the bladder;

The *prostatic plexus* leaves the front of the pelvic plexus, and supplies the substance of the prostate. At the front of the prostate an offset (cavernous) is continued onwards to the dorsum of the penis, to supply the cavernous structure. On the penis the cavernous nerves join the pudic nerve. to the prostate and penis:

In the female there are the following additional plexuses for the supply of the viscera peculiar to that sex :— offsets in the female,

Ovarian plexus. The chief nerves to the ovary are derived from the renal and aortic plexuses, and accompany the ovarian artery; but the uterine nerves supply some filaments to it. to the ovary;

Vaginal nerves. The nerves of the vagina are large, and are not plexiform, but consist in greater part of spinal nerve-fibres; they end in the lower part of the tube. to the vagina;

The *uterine nerves* are furnished to the uterus with only a small admixture of the spinal nerves; they ascend along the side of the uterus, and consist of long slender filaments without ganglia or communications. The Fallopian tube receives its branches from the uterine nerves. and to the uterus.

Some few nerves surrounding the arteries of the uterus are plexiform and ganglionic.

The LYMPHATIC GLANDS OF THE PELVIS form one chain in front of the sacrum, and another along the internal iliac vessels: their efferent ducts join the lumbar glands. Into these glands run the deep lymphatics of the penis, of the genital organs in the female, and the lymphatics of the viscera and wall of the pelvis. Chain of pelvic glands; lymphatics entering them.

SECTION II.

ANATOMY OF THE VISCERA OF THE MALE PELVIS.

DIRECTIONS. The rectum with the bladder and the bodies at its base, viz., the vesiculæ seminales, and the prostate gland, are now to be taken bodily away for examination.

Dissection. In order to remove them from the pelvis the student should carry the scalpel round the pelvic outlet, close to the osseous boundary, so as to detach the crus of the penis from the bone, and the end of the rectum from the parts around. When the viscera are removed, the rectum is to be separated from the other organs; but the bladder, the penis, and the urethra are to remain united. Take out the viscera, separate rectum;

After the bladder has been distended with air, the areolar tissue is to be removed from its muscular fibres. The prostate gland and the vesiculæ seminales are then to be cleaned; and the duct of the latter, with the vas deferens, is to be followed to the gland. clean the bladder,

Any integument left on the penis is to be removed. and penis.

THE PROSTATE GLAND AND SEMINAL VESICLES.

Prostate gland: situation; PROSTATE GLAND (fig. 151, p. 408). This is a firm muscular body containing glands, which surrounds the neck of the bladder and the beginning of the urethra. Its relations have already been enumerated at p. 388.

form; dimensions; The prostate is conical in form, like a chestnut, with the base directed upwards. Its dimensions are the following:—Transversely at the base it measures about an inch and a half; from apex to base an inch and a quarter; and from before backwards about three-quarters of an inch or an inch: so that an incision directed obliquely outwards and backwards will be the longest that can be practised in the half of this body. Its weight is about an ounce, but in this respect it varies greatly.

and weight.

Surfaces; The anterior surface of the prostate is narrow and rounded. The posterior surface, larger and flatter, is marked by a median hollow which indicates the division into lateral lobes.

base; and apex. The base is thick, and at its posterior part has a median notch, which receives the common seminal ducts. The apex is pierced by the urethra.

Three lobes, two lateral, Three lobes are described in the prostate, viz., a middle and two lateral, though there is no fissure in the firm mass. The *lateral lobes* (fig. 151, *b*, *c*) are similar on the two sides, and are separated only by the hollow on the under surface; they form the chief part of the prostate, and are prolonged back, on each side, beyond the notch in the base. The *middle lobe* (*d*) will be brought into view by separating the vesiculæ seminales and the vasa deferentia from the bladder: it is the piece of the gland between the neck of the bladder and the seminal ducts, which extends across between the lateral lobes. Oftentimes the middle lobe is enlarged in old people, and projects upwards into the bladder, so as to interfere with the flow of the urine from that viscus, or the passage of a catheter into it.

and a central,

often enlarged.

Gland contains three tubes. The urethra and the two common seminal ducts are contained in the substance of the prostate as will be seen immediately. The former is transmitted through the gland from base to apex; and the latter perforate it obliquely to terminate in the urethral canal.

Structure. *Structure.* On section the prostate appears reddish grey in colour, is very firm to the feel, and is scarcely lacerable. It is made up of a mass of muscular and fibrous tissues, with interspersed glandular substance; and the whole is enveloped by strong *proper capsule* and is surrounded by a fibrous sheath derived from the recto-vesical fascia, which is sometimes styled the *false capsule*.

Muscular fibres are plain— *Muscular tissue.* The firm mass of this body consists mainly of involuntary muscular fibres, intermixed with elastic and fibrous tissues. One set of muscular fibres is arranged circularly round the urethral canal,—these are continuous above with the annular fibres of the bladder, and below with a thin layer of circular fibres surrounding the membranous portion of the urethra; others run transversely behind the urethra, and radiate in each lateral lobe

circular,

radiating,

through the glandular substance. Over the greater part of the surface is an external stratum, forming a kind of capsule, which adheres to the fibrous sheath. Along the front and towards the apex, the superficial part of the organ is composed of striated muscular fibres, also disposed transversely, which are continued into the constrictor urethræ muscle between the layers of the triangular ligament. and superficial; and striped,

Glandular substance. This is composed of a number of small branched glands, which are embedded in the muscular stroma. There are three chief collections,—a small one in the central lobe, and a larger one in each lateral lobe. The ducts of the glands vary in number from twelve to twenty, and open into the prostatic part of the urethra (p. 413). Glands in three masses: ducts open into the urethra.

Blood-vessels. The *arteries* are small, and are furnished by the inferior vesical and middle hæmorrhoidal. The *veins* form a plexus round the gland, which receives in front the dorsal vein of the penis, and is continued behind into the plexus at the base of the bladder. The plexus is situated between the fascial investment and the proper capsule of the gland, and the vessels of the plexus are specially large at the back of the pubis at the entry of the dorsal vein of the penis. In old men these vessels may give rise to considerable hæmorrhage in the operation of lithotomy. Arteries. Veins form a plexus.

The *nerves* are supplied from the pelvic plexus. The *lymphatics* of this body and of the vesiculæ seminales are received into the glands by the side of the internal iliac artery. Nerves. Lymphatics.

Vesiculæ Seminales (fig. 151, *e*). These vesicles are two membranous sacs, which serve as receptacles for, and probably secrete a special fluid to mix with, the semen. They are placed at the base of the bladder above the prostate, and diverge from one another so as to limit laterally a triangular space in that situation: their form and relations have been already described (p. 389). Though sacculated and bulged above, the vesicula becomes straight and narrowed below (duct); and at the base of the prostate it blends with the vas deferens to form the common seminal or ejaculatory duct (*g*). Seminal vesicles: definition; situation; form;

The vesicula seminalis consists of a tube bent into a convoluted form, so as to produce lateral sacs or pouches, the bends of which are bound together by fibrous tissue; this cellular structure will be shown by means of a cut into it. When the bends of the vesicle are undone, as may be done by carefully dissecting away the investing tissue, its formative tube, which is about the size of a quill, measures from four to six inches in length, and ends above in a closed extremity: connected with the tube at intervals, are lateral blind cæcal appendages (fig. 151). consist of a folded tube; length and size.

Structure. The wall of the seminal vesicle like the vas deferens has an outer and inner layer of longitudinal muscle fibres with an intermediate circular layer, but the tubal muscular coat is thinner. Vesicle has usual coats;

Within the casing of the recto-vesical fascia, the vesiculæ and vas deferentia are covered by a layer of transverse and longitudinal plain muscular fibres. The transverse are the more superficial a covering of muscular fibres;

(the base of the bladder being upwards), and are strongest near the prostate, acting most on the vasa deferentia. The longitudinal fibres, placed chiefly on the sides of the vesiculæ, are continued forwards with the common seminal ducts to the urethra. (Roy. Med. Chir. Trans. 1856.)

and a mucous coat.

The *mucous membrane* is thrown into ridges by the bending of the tube, and presents an alveolar or honeycomb appearance; it is provided with tubular glands, as in the vas deferens.

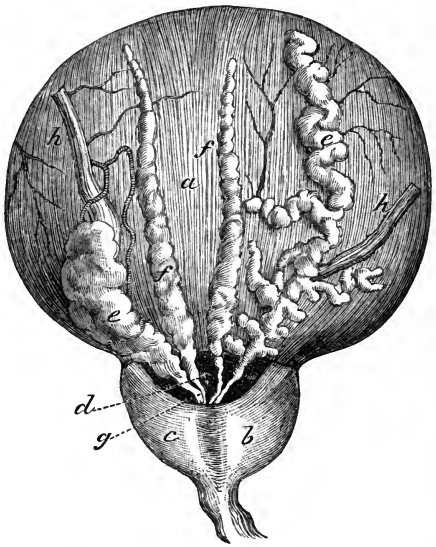


FIG. 151.—THE POSTERIOR SURFACE OF THE BLADDER, WITH THE VESICULÆ SEMINALES AND VASA DEFERENTIA (SLIGHTLY ALTERED FROM HALLER).

a. Bladder.
b and *c*. Right and left lateral lobes of the prostate.
d. Middle lobe.
e. Vesicula seminalis, the right one unravelled.
f. Vas deferens.
g. Common seminal duct, formed by the union of the vas deferens with the duct of the vesicula.
h. Ureter.

End of vas deferens.

End of vas deferens (fig. 151). Opposite the vesicula the vas deferens is enlarged, and is rather sacculated like the contiguous vesicle; but before it joins the tube of that body to form the common seminal duct, it diminishes in size, and becomes straight. In the mucous lining are numerous tubular glands (Henle).

Seminal ducts, how formed:

Common ejaculatory ducts (fig. 151, *g*, and fig. 153, *f*, p. 412). These tubes (right and left) are formed by the junction of the narrowed part or duct of the vesicula seminalis with the vas deferens of the same side.

extent; course;

They begin opposite the base of the prostate, and are directed downwards and forwards through an aperture in the transverse prostatic fibres, and along the sides of the uterus masculinus

(p. 412), to open into the urethral tube. Their length is rather less than an inch, and their course is convergent to their termination close to each other in the floor of the urethra. length; termination;

Structure. The wall of the common duct is thinner than that of the vesicula seminalis; but it possesses similar coats. It is surrounded by longitudinal involuntary muscular fibres, which blend in the urethra with the submucous stratum. structure.

THE BLADDER.

While the bladder is in the body, it is ovoidal in shape, and rather flattened from above down (pp. 387 and 388); but out of the body it is rounder than when in its natural position, and it loses the arched form by which it adapts itself in distension to the curve of the pelvis. Form;

If this viscus is moderately dilated, it measures about five inches in length, and three inches across. Its capacity is greatly influenced by the age and habits of the individual. Ordinarily the bladder holds about a pint without inconvenience during life, though it can contain much more when distended. dimensions.

STRUCTURE. A muscular and a mucous coat, with an intervening fibrous layer, exist in the wall of the bladder: at certain parts the peritoneum may be also enumerated as a constituent of the wall. The vessels and nerves are large. Coats of the bladder.

The imperfect covering of *peritoneum* has been described (p. 378). Peritoneal.

The *muscular coat* is formed of three thin layers of unstriated muscular fibres, viz., an external or longitudinal, a middle or circular, and an internal or submucous. Muscular has three strata.

The *longitudinal fibres* (fig. 152, 1) form a continuous covering, with the usual plexiform disposition of the muscular bundles, and extends from apex to base. Above, some are connected with the urachus and the subperitoneal fibrous tissue. Below, the posterior and lateral fibres enter the prostate; while the anterior are attached to the fascia covering the prostate, but a fasciculus on each side is united to the back of the pubis through the anterior true ligament of the bladder. On the front and back of the bladder the muscular layer is stronger, and its fibres more vertical than on the sides. Sometimes this outer layer of fibres is called *detrusor urinæ* from its action in the expulsion of the urine. External or longitudinal: attachments; forms detrusor urinæ.

The *circular fibres* (fig. 152, 2) are thin and scattered on the body of the bladder; but around the cervix they are collected into a thick bundle, the *sphincter vesicæ*, and are continuous below with the fibres of the prostate. When these fibres are hypertrophied, they project into the interior of the organ, forming the fasciculated bladder; and in some bodies the mucous coat may be forced outwards here and there between them, in the form of sacs, producing the sacculated bladder. Middle continuous with prostate.

The *submucous stratum* (fig. 152, 3) forms a continuous layer over the lower half of the bladder, but its fibres are scattered above. In the lower third of the viscus the fibres are longitudinal, and are continued around the urethra; but they become oblique above that Submucous layer: extent; fibres;

addition to it.

point. At the back of the bladder the layer is increased in strength by the longitudinal fibres of the ureters blending with it.

Strata are joined.

The muscular strata communicate freely, so that one cannot be separated from another without division of the connecting bundles of fibres. In both sexes the disposition of the fibres is similar (Roy. Med. Chir. Trans. 1856).

Fibrous coat.

Fibrous or submucous coat. A fibrous layer is placed between the muscular and mucous strata, and is enumerated as one of the coats of the bladder; it is composed, as in other hollow viscera, of areolar and elastic tissues, in which the vessels and nerves ramify.

Open the bladder.

Dissection. The bladder is now to be opened by an incision along the part of the upper and along the anterior surface; and the cut is to be carefully continued down the front of the prostate gland in the middle line, so as to open the prostatic portion of the urethra.

Mucous coat

The *mucous membrane* of the bladder is of a pale rose colour in the healthy state soon after death. It is continuous above with the lining of the ureters, and below with that of the urethra. It is very slightly united to the muscular layer; and it is thrown into numerous folds in the flaccid state of the viscus, except over a small triangular space behind the urethral opening.

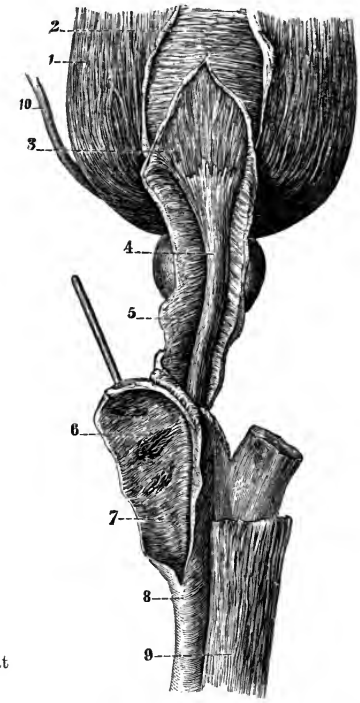


FIG. 152.—MUSCULAR FIBRES OF THE BLADDER, PROSTATE, AND URETHRA.

1. External or longitudinal fibres of the bladder.
2. Circular fibres of the middle coat.
3. Submucous layer.
4. Muscular layer around the urethra.
5. Circular fibres of the prostate and urethra continuous with the circular of the bladder.
6, 7. Septum of the corpus spongiosum.
8. Corpus spongiosum.
9. Corpus cavernosum.
10. Ureter.

has folds except at one part.

Interior of the bladder.

Objects inside the bladder. Within the bladder are the following special parts, viz., the orifices of the ureters and urethra, with the triangular surface (fig. 154, p. 414).

Opening of urethra,

Orifices. At the lower part of the bladder is the orifice of the urethra, surrounded by the prostate gland. The mucous membrane presents here some longitudinal folds; and the aperture is partly

closed by a small elongated prominence behind, *uvula vesicæ*, occasioned by a thickening of the submucous muscular and fibrous layers. This eminence is placed over the middle lobe of the prostate; and from its anterior end a slight ridge is continued on the floor of the urethra. with the uvula.

About an inch and a half from the orifice of the urethra, and rather more than that distance apart, are the two narrow openings of the ureters (fig. 154). The tubes perforate the wall of the bladder obliquely, lying in it for the distance of three-quarters of an inch, so that the reflux of fluid through them towards the kidney is prevented as the bladder is distended. Each terminates by a slit-like opening in a prominence of the subjacent muscular fibres. Openings of the ureters.

Trigone.

Triangular surface. Immediately behind the orifice of the urethra is a smooth triangular surface, which is named *trigone* (trigonum vesicæ; fig. 154, *a*). Its apex reaches the prostate, and its base the ureters. Its boundaries may be marked out by a line on each side from the urethra to the ureter, and by a transverse one, behind, between the openings of the ureters. This surface corresponds with the triangular space externally at the base of the bladder, between the vesiculæ seminales and vasa deferentia. Over it the mucous coat is more closely united to the muscular, so as to prevent the accidental folds occurring as in the other parts of the empty bladder. Trigone of the bladder: how bounded; part corresponding externally.

Dissection. The arrangement of the fleshy fibres of the ureters will come into view on the removal of the mucous membrane from the lower third of the bladder. To expose muscles of ureters.

Ending of the fibres of the ureter. As soon as the ureter pierces the outer and middle coats of the bladder, its longitudinal fibres are thus disposed:—the more internal and strongest are directed transversely, and join the corresponding fibres of the other urine tube; while the remainder are continued down over the triangular surface, and blend with the submucous layer of the bladder fibres. Muscular fibres of ureters.

Blood-vessels and nerves. The source of the vesical *arteries*, and the termination of the *veins*, have been detailed. The vessels are disposed in greatest number about the base and neck of the bladder. Most of the *nerves* distributed to the bladder, though supplied from the pelvic plexus of the sympathetic, are derived directly from the spinal nerves. The *lymphatics* enter the glands by the side of the internal iliac vessels. Arteries; veins; nerves of the bladder. Lymphatics.

The Urethra and Penis.

Urethra (fig. 154). The tube of the urethra extends from the neck of the bladder to the end of the penis, and has an average length of about eight inches; but it is shorter by one inch during life. It is supported by the prostate, the triangular ligament, and the spongy structure of the penis. The tube is Urethra: extent and length; division into parts.

divided, as already stated (pp. 389 and 390) into prostatic membranous and spongy parts.

How to open the urethra.

Dissection. To open the urethra, let the incision through the prostate be continued onwards to the extremity of the penis along the dorsal surface, passing as accurately as possible in the septum between the two corpus cavernosum.

Prostatic part: dimensions and shape; diameter.

The *prostatic part* (figs. 153 and 154) is nearer the anterior than the posterior surface of the mass surrounding it. It is one inch and a quarter in length, and is the widest portion of the urethral canal. Its form is spindle-shaped, for it is larger in the middle than at either end. Its transverse measurement at the neck of the bladder is nearly a third of an inch ; at its centre a line or two more ; and at the lower end rather less than at the beginning.

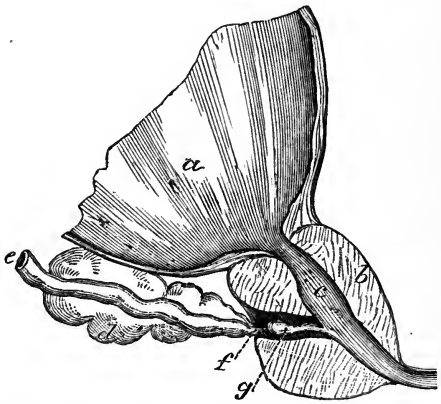


FIG. 153.—SECTION THROUGH THE BLADDER, PROSTATE, AND URETHRA, TO SHOW THE VESICULA PROSTATICA AND THE COMMON SEMINAL DUCT.

a. Bladder.
b. Prostate.
c. Prostatic part of urethra.
d. Vesicula seminalis.
e. Vas deferens.
f. Common ejaculatory duct.
g. Uterus masculinus ; above this is the middle lobe of the prostate.

On the floor is a crest:

Separating the prostatic portion of the urethra from the bladder is the eminence known as the uvula vesicæ. Beginning half an inch below this is a central longitudinal eminence of the mucous lining of the prostatic urethra (fig. 154, *d*), about three-quarters of an inch in length, and larger above than below, which is prolonged towards the membranous part of the canal, and is named *crest of the urethra* (verumontanum, caput gallinaginis) : it is formed of erectile substance, with a framework of elastic and muscular tissues. In the crest of the mucous membrane, near its posterior extremity, is

in the crest is a pouch.

the opening of the *uterus masculinus* or *utriculus* (sinus pocularis or vesicula prostatica).

Vesicula projects into the prostate,

The *uterus masculinus* (fig. 153, *g*) is a blind passage directed backwards in the prostate, from a quarter to half an inch, passing beneath the middle and between the lateral lobes. The student

can readily measure its length by passing a probe into it, and on opening it, it will be found that its blind extremity is somewhat dilated. Along its wall, on each side, is placed the *common seminal duct* (*f*), which terminates on or within the margin of the mouth of the sac; and if bristles are introduced into the common seminal duct behind the prostate, they will render the apertures evident. Small glands open on the surface of the mucous membrane lining the utricle, which is the remains of the united lower ends of the fœtal ducts of Muller, and represents the uterus and vagina in the female.

and by its side are the ejaculatory ducts.

On each side of the central crest is an excavation, which is named the *prostatic sinus* (fig. 154, *f*). Into this hollow the greater number of the ducts of the prostatic glands open; but the apertures of some are seen at the back of the central eminence.

Prostatic sinuses also in floor.

The MEMBRANOUS PART OF THE URETHRA (fig. 154, *g*) is three-quarters of an inch in length, and intervenes between the apex of the prostate gland and the bulb (*k*) of the corpus spongiosum urethræ. In its interior are slight longitudinal folds. This is the narrowest piece of the whole tube, with the exception of the outer orifice, and measures rather less than a quarter of an inch across. It is the weakest of the three portions of the canal, and is supported by a thin stratum of erectile tissue, by a thin layer of unstriated circular fibres, and outside all by the constrictor urethræ muscle.

Membranous part: dimensions; parts around.

The SPONGY PART (fig. 154, *i*) reaches to the end of the penis. It is about six inches in length, and its strength depends upon a surrounding material named the corpus spongiosum urethræ.

Spongy part:

The average size of the canal is about a quarter of an inch in diameter, though at the vertical slit (meatus urinarius), by which it terminates on the glans penis, the tube is smaller than elsewhere. On a cross section it appears star-shaped, but in the glans as a vertical slit. Two dilatations exist in the spongy portion;—one is along the floor close to the triangular ligament, being contained in the bulb or bulbous part of the urethra, and is named the *sinus of the bulb;* the other is an elongated hollow, situate in the glans penis, and is called the *fossa navicularis* (*n*).

dimensions; two dilatations,—one in bulb one in glans;

There are many small pouches or *lacunæ* (*o*) in the canal as far back as the membranous part, which have their apertures turned towards the outer orifice of the urethra. One of these, larger than the rest, *lacuna magna,* is found generally immediately within the meatus, in the roof of the fossa navicularis.

lacunæ, one larger than the rest.

The *ducts of Cowper's glands* (fig. 154, *h*) are two in number, and terminate, one on each side, on the floor of the urethra near the bulb; but their openings are generally too small to be recognised.

Ducts of glands of Cowper.

Mucous lining of the urethra. The mucous membrane of the urethra is continued into the bladder, as well as into the ducts opening into the canal, and joins in front the tegumentary covering of the glans penis. It is of a reddish colour in the spongy and membranous portions, but in the prostate it becomes whiter. In the spongy and membranous parts it is thrown into longitudinal folds during the contracted state of the penis.

Mucous membrane; colour; folds;

FIG. 154.—THE LOWER PART OF THE BLADDER AND THE URETHRA LAID OPEN.

a. Trigone of the bladder.
b. Openings of the ureters.
c. Prostate, cut.
d. Crest of urethra.
e. Uterus masculinus and utriculus.
f. Prostatic sinus, with openings of the glands of the prostate.
g. Membranous part of the urethra.
h. Cowper's glands, a duct from each opening into the urethra.
i. Spongy part of the urethra.
k. Bulb of the corpus spongiosum.
l. Glans penis.
n. Fossa navicularis.
o. Openings of the lacunæ and glands.
r. Corpus cavernosum of the penis.

Its surface is studded throughout with the apertures of minute glands, which are lodged in the submucous tissue, and the ducts of which are inclined obliquely forwards. glands.

Submucous tissue. Beneath the mucous lining of the urethra is a stratum of longitudinal unstriated muscular fibres, mixed with elastic and fibrous tissues. It is continuous behind with the submucous fibres of the bladder, and is joined in the prostate by the muscular fibres accompanying the common seminal ducts. The stratum differs at spots :—it is most developed in the prostate ; in the membranous portion the muscular structure is less abundant ; and in the spongy part fibrous tissue forms most of the submucous layer. Submucous tissue: nature; arrangement in urethra.

Around the membranous and prostatic divisions of the urethra there is, in addition, immediately beneath the mucous membrane, a thin layer of vascular or erectile tissue, which is continued backwards from the corpus spongiosum to the neck of the bladder. Erectile tissue throughout.

STRUCTURE OF THE PENIS. The form and the relations of the penis having been described (pp. 251 *et seq.*) the bodies of which it is composed remain to be noticed. If a section is made along one side of the penis, it will show this organ to be composed of two masses of spongy and vascular tissue (corpora cavernosa) encased in a fibrous covering, with an imperfect septum between them, and having the corpus spongiosum attached along their under surface. Penis formed of two vascular erectile bodies.

CORPORA CAVERNOSA (fig. 154, *r*). These bodies form the bulk of the penis, and are two dense cylindrical tubes of fibrous tissue, containing erectile structure. Each is fixed behind by a pointed process, *crus penis*, to the conjoined rami of the ischium and pubis for about an inch, and blends with its fellow in the body of the penis, about an inch and a half from its posterior extremity. There is a slight swelling on the crus, called the bulb of the corpus cavernosum (Kobelt). Corpora cavernosa attached behind separately, blend together in front: bulb.

Each corpus cavernosum is composed of a fibrous case containing a cavernous or trabecular structure, with blood-spaces between the trabeculæ of the spongy mass. An incomplete median septum exists along the body of the penis. Structure:

The *fibrous case* is a white, strong, elastic covering which, along the middle of the penis, sends inwards a septal process between the two corpora cavernosa as well as numerous other finer threads, which are connected with the trabeculæ of the spongy structure, of which the corpus cavernosum is composed. a case that sends in processes;

It is formed of white shining fibres which are disposed in two layers, outer and inner. The outer stratum is formed of longitudinal fibres with close meshes. The inner stratum consists of circular fibres, with a like plexiform disposition ; and the circular fibres of each cavernous body meeting in the middle line give rise to the septum penis. Both strata are inseparably united by communicating bundles. fibres form strata ;

The *septal process* (fig. 155) is placed vertically along the body of the penis, and is thicker and more perfect behind than in front. Near the junction of the crura this partition divides the enclosed a septal piece,

which is imperfect; cavity into two; but as it reaches forwards it becomes less strong, and is pierced by elongated apertures, which give it the appearance of a comb, from which its name, *septum pectiniforme,* is derived.

how formed; Through the intervals in the septum the vessels in the corpora cavernosa communicate. It is formed by the circular fibres of the fibrous case.

and numerous bands and cords to form a network. The *cavernous* or *trabecular structure* is a network of fine threads, which fills the interior of the corpora cavernosa. Its processes are thinner towards the centre than at the circumference; and the areolar spaces are larger in the middle and at the fore part of the contained cavity, than at the circumference or in the crura of the penis. The spongy structure may be demonstrated by sections of the penis, after it has been distended with air and dried.

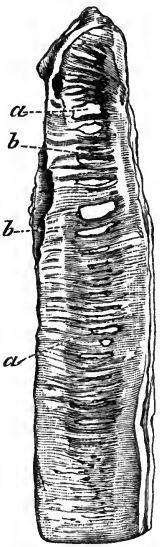


Fig. 155.—Pectiniform Septum of the Penis.

a. Apertures in the partition.

b. Separate fibrous processes like the teeth of a comb, which are formed by the circular fibres.

Vessels. *Blood-vessels.* The blood-vessels of the penis are of large size, and serve to nourish as well as to minister to the functions of the organ. Having entered the cavernous mass, they ramify in the trabecular structure.

Source of the arteries; The *arteries* of the corpora cavernosa are offsets of the pudic; the chief branch (*artery of the corpus cavernosum;* p. 251) enters at the crus, and runs forwards through the middle of the cavernous structure, distributing offsets; and the rest, coming from the dorsal artery (p. 251), pierce the fibrous case along the dorsum of the penis.

termination in venous spaces. In the interior they divide into branches, which ramify in the trabeculæ, becoming finer, until they terminate in very minute branches, which open into the intertrabecular venous spaces. By the distension of these spaces the erection of the corpora cavernosa is produced.

Veins in two sets. The *veins* spring from the intertrabecular spaces, and some issue along the upper and under aspects of the penis to join the dorsal vein; but the principal trunks escape at the crus penis and pass to the pudic veins.

Spongy material of the penis: Corpus spongiosum urethræ. This constituent part of the penis surrounds the urethra, but not equally on all sides; for at the bulb only a thin stratum is above the canal, while at the glans penis (fig. 154, *l*) the chief mass is placed above the urethral tube.

its structure like cavernous. *Structure.* The tissue of the corpus spongiosum is similar to that of the corpus cavernosum; thus it consists of a fibrous tunic enclosing a trabecular structure with blood-spaces.

The fibrous case. The *fibrous covering* is less dense and strong than in the corpora cavernosa, and consists only of circular fibres. A *septal piece*

projects inwards from it in the middle line, opposite the tube of the urethra; this is best marked for a short distance in front of the bulb, and assists in dividing that part into two lobes. The *trabecular bands* are much finer, and more uniform in size than in the corpora cavernosa. imperfect septum; trabeculæ.

Blood-vessels. The arrangement of the blood-vessels in the erectile structure of the corpus spongiosum is similar in the bulb to that in the corpora cavernosa; but in the rest of the spongy substance the arteries are said to end in capillaries in the usual way. Blood-vessels:

The *arteries* are derived from the pudic on each side; a large one behind, the *artery of the bulb* (p. 251), enters the upper surface of the bulb; and several in front, offsets of the dorsal artery of the penis, penetrate the glans. Kobelt describes another branch to the fore part of the bulb. source of arteries;

Most of the *veins*, including those of the glans, end in the large dorsal veins of the penis, some communicating with veins of the cavernous body; others issue from the bulb, and terminate in the pudic vein. termination of the veins.

Nerves and lymphatics. The *nerves* of the penis are large, and are supplied, as previously described, by both the spinal and sympathetic nerves. The *superficial lymphatics* of the integuments, and those beneath the mucous membrane of the urethra, join the inguinal glands; the *deep* accompany the veins beneath the subpudic arch, to end in the lymphatic glands in the pelvis. Nerves. Lymphatics.

THE RECTUM.

Dissection. The rectum is to be washed out and then distended with tow, and the peritoneum and the loose fat are to be removed from it. To prepare the gut.

This portion of the intestine is about five inches in length. Its lower half is commonly dilated, especially in old people, and the anal canal in which it terminates is the narrowest part of the large bowel. It is sacculated, although not so distinctly as the colon; the pouches are arranged in two rows, right and left, and they become larger and less numerous towards the lower end. Rectum: length; dimensions; sacculi.

Structure. The rectum contains in its wall a peritoneal, a muscular, a submucous, and a mucous stratum; and the muscular and mucous coats have certain characters which distinguish this part of the intestinal tube. Same coats as in the rest of the intestine:—

The *peritoneum* forms but an incomplete covering, and its arrangement is referred to in the description of the relations of the pelvic viscera (p. 386). Peritoneum.

The *muscular coat* consists of two layers of pale or unstriated fibres, viz., a superficial or longitudinal, and a deep or circular. The *longitudinal* fibres are mainly collected into anterior and posterior bands, which spread out and increase in thickness below: the anterior band is the broader, and is formed by the union of two of the bands of the colon, while the posterior is the continuation of the band lying along the attached border of the colon. These Muscular coat has longitudinal

and circular fibres.

bands are shorter than the other strata of the wall, and thus give rise to the sacculations. The *circular* fibres describe arches around the intestine, and become thicker and stronger towards the anus, where they are collected along the anal canal into the band of the internal sphincter muscle (p. 240).

Mucous coat is thick and vascular; folds in it.

The *mucous coat* is more moveable than in the colon, and resembles in this respect the lining of the œsophagus; it is also thicker and more vascular than in the rest of the large intestine.

When the bowel is contracted the mucous lining is thrown into numerous accidental folds, for the most part transverse or oblique; but in the anal canal they are longitudinal, enclosing submucous muscular fibres, and form the *columns of Morgagni*. There are also permanent transverse folds of the intestinal wall (*Rectal valves*) corresponding to the depressions between the sacculi externally. The largest and most regular of these are in the lower portion of the gut, one being on the right side and front about three inches from the anus, and corresponding approximately to the spot where the recto-vesical pouch of peritoneum ends, another on the left side about one inch higher, and a third, which is less constant, on the left side posteriorly, below the first. These folds will be seen by laying open the gut along the front, provided it is tolerably fresh.

Permanent folds in wall of rectum.

"Rectal valves."

Structure of membrane.

The mucous membrane has the same general structure as in the colon, but towards the anus the secretory apparatus disappears.

Arteries:

Blood-vessels. The *arteries* are supplied from three different sources, viz., superior hæmorrhoidal of the inferior mesenteric, middle hæmorrhoidal of the internal iliac, and inferior hæmorrhoidal of the internal pudic. All three sets anastomose on the lower end of the gut; but only the upper hæmorrhoidal, which is the largest, requires notice here. The final branches of this artery, about six in number, pierce the muscular layer three inches from the anus, and descend between the mucous and muscular coats as far as the internal sphincter, where they unite in loops just within the anus.

arrangement of superior hæmorrhoidal.

Veins are without valves.

The *veins* have no valves, and communicate freely in a large plexus (hœmorrhoidal) between the muscular and mucous coats, round the lower end of the gut. Above they join the inferior mesenteric vein, and through it reach the vena portæ; and below they pour some blood into the internal iliac vein by the middle and inferior hæmorrhoidal branches.

Nerves.

Lymphatics.

Nerves and lymphatics. The *nerves* of the intestine are obtained from the sympathetic; but those of the external sphincter come from the spinal nerves. The *lymphatics* terminate in the chain of glands on the sacrum.

Section III.

ANATOMY OF THE FEMALE PELVIC VISCERA.

To remove the viscera,

Dissection. In the case of the female pelvis, the bladder, urethra, the genital organs and the rectum are to be removed together for

separate examination. For this purpose the student should keep the scalpel close to the osseous boundary of the pelvic outlet, so as to avoid injuring the end of the rectum; and he should also detach the crus of the clitoris from the bone.

After the parts are taken from the body, the rectum is to be separated from the uterus and the vagina, but the rest of the viscera may remain united until after the genital organs are examined. The bladder and rectum may be moderately distended; and the fat and areolar tissue are to be removed from the viscera. and prepare them.

GENITAL ORGANS.

The genital organs, or external organs of generation, consist of the following parts:—the mons Veneris and external labia, the clitoris and internal labia, and the vestibule with the meatus urinarius; they have been seen in the dissection of the perineum (p. 255 *et seq.*). Within the internal labia is the aperture of the vagina, with the hymen. The name *vulva* or *pudendum* is applied to these parts as a whole. External organs of generation

GENERATIVE ORGANS.

The generative organs, or internal organs of generation, are the uterus and vagina, and the ovaries with the Fallopian tubes. Separate vagina and uterus;

Dissection. The viscera are now to be separated, so that the bladder and the urethra may be together, and the vagina and the uterus remain united. The bladder is to be set aside for subsequent examination. The surface of the vagina and the lower part of the uterus should be cleaned; but the peritoneal investment of the latter is to be left untouched for the present. clean vagina.

THE VAGINA.

The general relations of the vagina have been described on page 394. The tube of the vagina (fig. 146, p. 391), is connected with the uterus at one end, and with the vulva at the other. It has a slightly curved course between the two points mentioned; and the anterior and posterior walls are not equal in length, for the former measures about two inches, and the latter three. Vagina: extent and curved course;

In the body the vagina is flattened from before backwards, so that the opposite surfaces are in contact; and the upper part of the posterior wall is applied to the lower end of the uterus. Its size varies at different spots;—thus the external orifice, which is surrounded by the constrictor vaginæ muscle, is the narrowest part; the middle portion is the largest; and the upper end is intermediate in dimensions between the other two. form and size.

After the vagina has been laid open by an incision along the side, the position of the uterus in the anterior wall, instead of at the extremity of the passage, may be remarked; and the tube may be seen to extend farther on the posterior than on the anterior lip of the Interior.

os uteri. On the inner surface, towards the lower part, is a longi-
has columns and rugæ. tudinal ridge both in front and behind, named *columns of the vagina*.
Thickness. Before the tissue of the vagina has been distended, other transverse ridges or rugæ pass between the columns. The wall of the vagina is thicker in front round the urethra than at any other part of the canal.

Three coats: mucous, muscular, and fibrous; *Structure.* The vaginal wall has a muscular coat, composed of unstriped fibres both longitudinal and circular, which is thin above, and increases in thickness below. It is lined internally by mucous membrane, and covered externally by a layer of connective tissue containing a dense network of veins. The prominence of the columns is mainly due to a collection of vascular cavernous tissue between the mucous and muscular layers.

also erectile tissue.

Mucous membrane. The *mucous membrane* is continued through the lower aperture to join the integument on the labia majora, and through the os uteri, at the opposite end, to the interior of the uterus. Many mucous glands open on the surface, especially at the upper part.

Arteries. *Blood-vessels and nerves.* The *arteries* are derived from the vaginal
Veins are plexiform. and uterine branches of the internal iliac. The *veins* form a plexus around the vagina, as well as in the genital organs, and open into
Nerves. the internal iliac vein. The *nerves* are derived from the pelvic plexuses, as described on page 404.

Lymphatics. The *lymphatics* accompany the blood-vessels to the glands by the side of the internal iliac artery.

THE UTERUS.

Uterus: The uterus or womb is formed chiefly of unstriated muscular fibres. Its office is to receive the ovum, and to contain the developing fœtus.

form; This viscus in the virgin state is somewhat pear-shaped, the body being flattened (fig. 146 and fig. 156, p. 422), and the narrow end below.

dimensions; Before impregnation the uterus measures about three inches in length, two in breadth at the upper part, and an inch in greatest thickness. Its weight varies from an ounce to an ounce and a half. But after gestation its size and volume always exceed the measurements here given.

upper end; The upper end is convex, and is covered by peritoneum: the name *fundus* is given to the part of the organ above the attachment of the Fallopian tubes.

the lower end is small, and has an opening; The lower end is small and rounded, and in it is a transverse aperture of communication between the uterus and the vagina, named *os uteri externum:* its margins or *lips* (*labia*) are smooth, and anterior and posterior in situation, but the hinder one is the longer and thinner. Towards the lower part the uterus is con-
neck; stricted; and the smaller portion is called the *neck* (*cervix uteri; b*); it is nearly an inch in length, and gradually tapers towards the extremity, where it projects into the vagina, being enclosed by this tube to a greater extent behind than in front.

The *body* (*a*) of the uterus is more convex posteriorly than anteriorly, and decreases in size down to the neck. It is covered on both aspects by the peritoneum, except at the lower part in front (about half an inch), where it is connected to the bladder. To each side the parts contained in the broad fold of the peritoneum are attached (p. 391), viz., the Fallopian tube at the top, the round ligament rather below and before the last, and the ovary and its ligament below and behind the others.

body;

parts attached to side.

Dissection. To examine the interior of the uterus, a cut is to be made along the front from the fundus to the external os uteri; and then some of the thick wall is to be removed on each side of the middle line to show the contained cavity (fig. 156).

Open the uterus.

The *thickness* of the uterine wall is greatest opposite the middle of the body. It is greater at the centre than at the extremities of the fundus, the wall becoming thinner towards the attachment of the Fallopian tubes.

Its thickness.

Interior of the uterus. Within the uterus is a small space, which is divided artificially into two—that of the body, and that of the neck.

In the interior

The space occupying the body of the viscus (*c*) is triangular in form, and compressed from before backwards. Its base is at the fundus, where it is convex towards the cavity, and the angles are prolonged into the Fallopian tubes. The apex is directed downwards, and joins the cavity in the neck by a narrowed circular part, or isthmus (*os uteri internum*) which may be narrower than the opening of the uterus into the vagina.

is a triangular space in the body,

which is narrowed below;

The space within the neck (*d*) terminates below at the external os uteri, and is continuous above with the cavity within the body. It is larger at the middle than at either end, being spindle-shaped, and is somewhat flattened like the cavity of the body. Along both the anterior and the posterior wall is a longitudinal ridge; and other ridges (*rugæ*) are directed obliquely from these on each side: this appearance has been named *arbor vitæ uterinus*. In the intervals between the rugæ are mucous follicles, which sometimes become distended with fluid, and give rise to rounded clear sacs.

and a spindle-shaped space in the neck.

In the neck are ridges of arbor vitæ.

Structure. The dense wall of the uterus is composed of layers of unstriated muscular fibre, intermixed with areolar and elastic tissues and large blood-vessels. On the exterior is the peritoneum; and lining the interior is a thin mucous membrane.

Uterus is a muscular organ.

The *muscular fibres* can be demonstrated at the full period of gestation to form three strata in the wall of the uterus, viz., external, internal, and middle:—

There are three strata,

The external layer contains fibres which are mostly transverse; but at the fundus and sides they are oblique, and are more marked than along the middle of the organ. At the sides the fibres converge towards the broad ligament; some are inserted into the subperitoneal fibrous tissue; and others are continued into the Fallopian tube, the round ligament, and the ligament of the ovary.

external,

The internal fibres describe circles round the openings of the Fallopian tubes, and spread from these apertures till they meet at

internal,

the middle line. At the neck of the uterus they are arranged in a transverse direction.

and middle. The middle or intervening set of fibres are more indistinct than the others, and have a less determinate direction.

Mucous membrane. The *mucous lining* of the uterus is continued into the vagina at one end, and into the Fallopian tubes at the other. In the body it is thin and soft, of a reddish-white colour, smooth, and closely adherent. In the cervix it is stronger, and presents the folds before referred to.

Vessels are large. The *blood-vessels* of the uterus are large and tortuous, and occupy canals in the uterine substance in which they communicate freely

Arteries. together. The *arteries* are furnished from the uterine, vaginal and

Veins. ovarian vessels (p. 398 *et seq.*) and the *veins* correspond with the

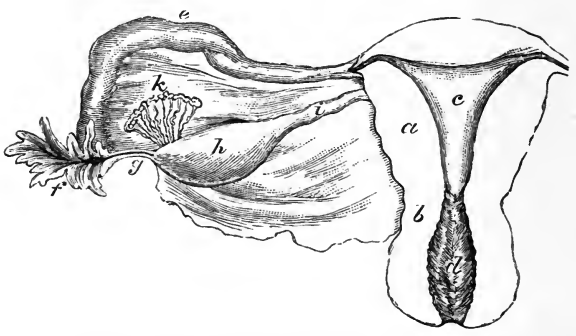


Fig. 156.—Interior of the Uterus, with a Posterior View of the Broad Ligament and the Uterine Appendages.

a. Body, and *b*, neck of the uterus.
c. Cavity of the body, and *d*, of the neck.
e. Fallopian tube, and *f*, its trumpet-shaped end.
g. The fimbria attached to the ovary.
h. Ovary.
i. Ligament of the ovary.
k. Parovarium.

arteries ; they are of large size, and form plexuses in the uterus, which communicate with the vaginal plexus on the one hand and the ovarian on the other.

Nerves. The *nerves* are derived from the sympathetic (p. 405), and are very small in proportion to the size of the uterus.

Lymphatics ; two sets. *Lymphatics.* One set accompanies the uterine vessels to the glands on the iliac artery. Another set issues from the fundus, enters the broad ligament, and accompanies the ovarian artery to the glands on the aorta : the last are joined by lymphatics of the ovary and Fallopian tube.

Round ligament ends in groin ; attachment to uterus, *Round ligament of the uterus* (p. 394). This firm cord supports the uterus, and is contained partly in the broad ligament, and partly in the inguinal canal. It is about five inches in length, and is attached to the upper end of the uterus close below and in front of the Fallopian tube. A process of the peritoneum

accompanies it in the inguinal canal, and remains pervious sometimes for a short distance.

The ligament is composed of unstriated muscular fibres, derived from the uterus, together with vessels and areolar tissue. how formed.

OVARIES AND FALLOPIAN TUBES.

Ovary (fig. 156, *h*). The ovaries are two bodies, corresponding with the testes of the male. They are contained in the broad ligaments of the uterus, one in each. Ovary: position;

Each ovary is of an oval form, and somewhat compressed in one direction. It is of a whitish colour, with either a smooth or a scarred surface. Its volume is variable; but in the virgin state it is about one inch and a half in length, half as much in width, and a third of an inch in thickness. Its weight varies from one to two drachms. form and colour; dimensions and weight.

The ovary is placed at the back of the broad ligament, and is attached to that membrane by one margin, where the vessels enter the organ at the *hilum*. The other margin and both surfaces are free. One end (the upper in the natural position) is rounded, and is connected with one of the fimbriæ (*g*) at the mouth of the Fallopian tube. The opposite extremity is narrowed, and is fixed to the side of the uterus by a fibrous cord,—the ligament of the ovary (*i*), below the level of the Fallopian tube and round ligament. Connections.

Fig. 157.—Ovary during the Child-bearing Period Laid Open (Farre).

a. Graafian vesicles in different stages of growth.

b. Plicated body remaining after the escape of the ovum.

Structure. The ovary consists of a stroma enclosing small sacs named Graafian vesicles, which contain the ova, and the whole is surrounded by a fibrous tunic. The peritoneum invests it except at the attached margin. Structure

The *fibrous coat* is continuous with the contained stroma. Sometimes a yellow spot (corpus luteum), or some cicatrices, may be seen in this covering. a fibrous coat;

Stroma (fig. 157). The substance of the ovary is spongy, vascular, and fibrous. At the centre the fibres radiate from the hilum towards the circumference. But at the exterior is a granular material (cortical layer) which contains very many small follicles, about $\frac{1}{100}$th of an inch in size—the nascent Graafian vesicles. stroma;

The *Graafian vesicles* or *ovisacs* (fig. 157) are round and transparent sacs, containing fluid, and scattered through the stroma of the ovary below the cortical layer. During the child-bearing period some are larger than the rest (*a*); and of this larger set ten to thirty, or more, may be counted at the same time, which vary in size from a pin's head to a small pea. The largest are situate at the Graafian vesicles, number and size.

circumference of the organ, and sometimes they may be seen projecting through the fibrous coat.

Shedding of an ovum:

When the Graafian vesicle is matured it bursts on the surface of the ovary, and the contained ovum escapes into the Fallopian tube. After the shedding of the ovum the ruptured vesicle gives origin to a yellow substance, *corpus luteum*, which finally changes into a cicatrix (*b*).

corpus luteum.

Artery;

Blood-vessels and nerves. The *ovarian artery* pierces the ovary at the attached border, and its branches run in zigzag lines through the stroma, to which and the Graafian vesicles they are distributed.

veins;

The *veins* begin in the texture of the ovary, and after escaping from its substance, forms a plexus (*pampiniform*) within the fold of the broad ligament.

nerves.

The *nerves* are derived from the sympathetic on the ovarian and uterine vessels.

Appendage to ovary:

Parovarium or *organ of Rosenmuller* (*epoophoron* of Waldeyer; fig. 156 *k*).

situation:

On holding up the broad ligament of the uterus to the light, a collection of small tortuous tubules will be seen between the ovary and the Fallopian tube.

form;

These are the remains of the upper part of the Wolffian body of the fœtus, and correspond to the vasa efferentia of the testicle in the male. The mass is about one inch broad, with its base to the Fallopian tube and its apex towards the attached border of the ovary.

structure.

The small tubes are from twelve to twenty in number; at the wider end they are joined more or less perfectly by a tube crossing the rest (the remnant of the Wolffian duct), which is prolonged sometimes a short way into the broad ligament.

Fallopian tube:

FALLOPIAN TUBES (fig. 156, *e*). Two in number, one on each side, they convey the ova from the ovaries to the uterus.

length;

Each is about four inches in length; cord-like at the inner end, where it is attached to the upper part of the uterus, it increases in

and form;

size towards the outer end, and terminates in a wide extremity (*f*),

it is dilated externally,

like the mouth of a trumpet. This dilated end is fringed, and the pieces are called *fimbriæ*.

and fimbriated;

When the fimbriated end is floated out in water, one of the processes (the ovarian fimbria; *g*) may be seen to be fixed to the distal end of the ovary. In the centre of the fimbria is a groove leading to the orifice of the Fallopian tube.

size of the canal is least at the ends.

On opening the tube with care, the size of the contained space and its small aperture into the uterus can be observed. Its canal varies in size at different spots; the narrowest part is at the orifice into the uterus (ostium uterinum), where it scarcely gives passage to a fine bristle; towards the outer end it increases a little, but it is rather diminished in diameter at the outer aperture (ostium abdominale).

A muscular structure;

Structure. This tube has the same structure as the uterus with which it is connected, viz., a muscular layer covered externally by peritoneum, and lined by mucous membrane.

fibres prolonged from uterus.

The *muscular coat* is formed of an external or longitudinal, and an internal or circular layer; both these are continuous with similar strata in the wall of the uterus.

Mucous coat

The *mucous membrane* forms longitudinal folds, particularly at the outer end. At the inner extremity of the canal it is continued

into the mucous lining of the uterus, but at the outer end it joins the peritoneum. is continuous with peritoneum.

The *blood-vessels* and *nerves* are furnished from those supplied to the ovary and uterus. Vessels.

THE BLADDER, URETHRA, AND RECTUM.

BLADDER. The peculiarities in the form of the female bladder have been detailed in the description of the relations of the viscera of the female pelvis (p. 394). For a notice of its structure, the anatomy of the male bladder is to be referred to (p. 409). Anatomy of bladder.

Dissection. To prepare the bladder, distend it with air, and remove the peritoneal covering and the loose tissue from the muscular fibres. Preparation of it;

After the external anatomy of the bladder and urethra has been learnt, they are to be slit open along the fore part, as described in the dissection of the male parts. open it.

URETHRA. The length and the relations of the urethra are given at p. 395. Urethra: length;

The average diameter of the urethra is rather more than a quarter of an inch, and the canal is enlarged and funnel-shaped towards the neck of the bladder; near the external aperture is a hollow in the floor. In consequence of its not being surrounded by resistant structures, the female urethra is much more dilatable than the corresponding passage in the male. size; it can be much dilated.

Structure. Like the urethra of the male, it consists of a mucous coat, which is enveloped by a plexus of blood-vessels, and by muscular fibre. Tube like that in the male.

The *muscular layer* extends the whole length of the urethra. Its fibres are circular, corresponding with those in the prostatic enlargement of the other sex, and continuous above with the middle layer of the bladder. In the perineal ligament this stratum is covered by the fibres of the deep transverse muscle. Muscular coat of circular fibres.

The *mucous coat* is pale except near the outer orifice. It is marked by longitudinal folds; and one of these, in the floor of the canal, resembles the median crest in the male urethra (p. 412). Around the outer orifice are some *mucous follicles;* and towards the inner end are tubular *mucous glands*, the apertures of which are arranged in lines between the folds of the membrane. Mucous coat: a fold in the floor; follicles and glands.

A *submucous stratum* of longitudinal elastic and muscular tissues lies close beneath the mucous membrane, as in the male. Submucous tissue.

Dissection. The RECTUM may be prepared for examination by distending it with tow, and by removing the peritoneal covering and the areolar tissue from its surface. Its structure is similar in the two sexes; and the student may use the description in the SECTION on the viscera of the male pelvis (p. 417 *et seq.*). Preparation of rectum. Rectum like that of the male.

INTERNAL MUSCLES AND LIGAMENTS OF THE PELVIS.

Two muscles, the pyriformis and obturator internus, have their origin within the cavity of the pelvis. Two muscles.

Define the muscles

Dissection. Take away any fascia or areolar tissue which may remain on the muscles; and define their exit from the pelvis,—the pyriformis passing through the great, and the obturator through the small sacro-sciatic foramen. On the right side the dissector may look to the attachment of the levator ani muscle to the pubic part of the hip-bone.

and the levator ani.

Pyriformis:

The PYRIFORMIS MUSCLE is directed outwards through the great sacro-sciatic foramen to the great trochanter of the femur. The muscle has received its name from its form.

origin in the pelvis;

In the pelvis the pyriformis *arises* by three slips from the second, third, and fourth pieces of the sacrum, between and external to the anterior sacral foramina; as it passes from the pelvis, it takes origin also from the surface of the hip-bone forming the upper boundary of the large sciatic notch, and from the great sacro-sciatic ligament.

insertion;

From this origin the fibres converge to the tendon of *insertion* into the great trochanter of the femur.

relations with parts around;

The anterior surface is in contact with the sacral plexus, with the sciatic and pudic branches of the internal iliac vessels, and with the rectum on the left side. The opposite surface rests on the sacrum, and is covered by the great gluteal muscle outside the pelvis. The upper border is near the hip-bone, the gluteal vessels and the superior gluteal nerve being between; and the lower border is contiguous to the coccygeus muscle, the sciatic and pudic vessels and nerves intervening.

use as an external rotator of hip-joint.

Action. The pyriformis belongs to the group of external rotators of the hip-joint; and its use has been given with the description of the rest of the muscle in the dissection of the buttock (p. 117).

Obturator internus

The OBTURATOR INTERNUS MUSCLE has its origin in the pelvis, and insertion at the great trochanter of the femur, like the preceding; but the part outside forms an acute angle with that inside the pelvis.

is bent over ischium;

origin in the pelvis;

The muscle *arises* by a broad fleshy attachment from the obturator membrane, except from a small part below, from the pelvic fascia covering its surface, slightly from the bone anterior to the thyroid hole and from all the smooth inclined surface of the pelvis (fig. 139, p. 369) behind and above that aperture except opposite the small sacro-sciatic foramen where a thin layer of fat separates the fleshy fibres from the bone. The fibres are directed backwards and downwards, and end in four or five tendinous pieces, which turn over the edge of the hip-bone corresponding with the small sciatic notch. Outside the pelvis the tendons blend into one, which receives the fibres of the gemelli and is *inserted* into the upper border of the great trochanter of the femur.

arching of its tendons over the hip-bone;

insertion;

relations of part in pelvic cavity;

The muscle is in contact by one surface with the wall of the pelvis and the obturator membrane; by the other surface with the obturator part of the pelvic fascia, and towards its lower border with the pudic vessels and nerve.

use.

Action. The muscle is chiefly an external rotator of the femur (p. 123).

Coccygeus muscle.

COCCYGEUS MUSCLE. The position and the relations of this muscle may now be studied from within: it is described on p. 381.

Section IV.

LIGAMENTS OF THE PELVIS.

The sacrum is joined at its base to the last lumbar vertebra, at its apex to the coccyx, and laterally to the two hip-bones. And the hip-bones are connected together at the symphysis pubis in front. Outline of the articulations.

Union of pieces of the sacrum and coccyx. So long as the pieces of the sacrum and coccyx remain moveable they are articulated as in the other vertebræ by an anterior and a posterior common ligament, with an intervertebral disc for the bodies, and by ligaments for the neural arch and processes. Ligaments of pieces separate,

After the sacral vertebræ have coalesced, only rudiments of the ligaments of the bodies are to be recognised; and when the pieces of the coccyx unite by bone, their ligaments disappear. and joined.

Lumbo-sacral articulation. The base of the sacrum is articulated with the last lumbar vertebra by ligaments similar to those uniting one vertebra to another (pp. 492 *et seq.*); and by one special ligament—the lateral lumbo-sacral. Sacrum with last lumbar vertebra.

Dissection. For the best manner of bringing these different ligaments into view, the dissector may consult the directions given for the dissection of the ligaments of the vertebræ (pp. 492 *et seq.*). Dissection.

The *common ligaments* for the bodies of the two bones are an anterior and a posterior, with an intervening fibro-cartilaginous substance. Between the neural arches lie the ligamenta subflava, and between the spines the supra- and interspinous bands. The articular processes are united by capsular ligaments with synovial membranes. By ligaments as in other vertebræ,

The *lateral lumbo-sacral ligament* is a variable bundle of fibres, which reaches from the under surface of the tip of the transverse process of the last lumbar vertebra to the lateral mass at the base of the sacrum. Widening as it descends, the ligament joins the fibres in front of the sacro-iliac articulation. and by a special lateral band.

Sacro-coccygeal articulation. The sacrum and coccyx are united at the centre by a fibro-cartilage, and by an anterior and a posterior ligament. There are also lateral and interarticular ligaments on each side. Union of sacrum and coccyx.

Dissection. Little dissection is needed for these ligaments. When the areolar tissue has been removed altogether from the bones, the ligaments will be apparent. Dissection.

The *anterior ligament* (sacro-coccygeal) consists of a few fibres that pass between the bones in front of the fibro-cartilage. An anterior and

The *posterior ligament* is wide at its attachment to the margin of the lower opening of the sacral canal, but narrows as it descends to be inserted in the coccyx. a posterior ligament,

The *fibro-cartilage* resembles that between the bodies of the other vertebræ, and is attached to the surfaces of the bones. with a fibro-cartilage.

Interarticular ligaments. The cornua of the sacrum and coccyx do not usually form joints, but are united by a ligamentous band on each side. A band between articular,

and transverse processes.

The *lateral ligament* passes on each side between the projections representing the transverse processes of the last sacral and first coccygeal vertebræ.

Motion.

Movement. While the coccyx remains unossified to the sacrum, a slight antero-posterior movement will take place between them.

Sacro-sciatic ligaments are two:

Two SACRO-SCIATIC LIGAMENTS pass from the side of the sacrum and coccyx to the hinder border of the hip-bone, across the space between those bones at the back of the pelvis : they are named great and small.

great,

The *great* or *posterior ligament* (fig. 158, *a*) is attached above to the posterior inferior iliac spine, and to the side of the sacrum and coccyx ; and below to the inner margin of the ischial tuberosity, sending forwards a prolongation (*falciform process*) along the ramus of the ischium. It is wide at the sacrum, and gets narrower towards the lower end ; but it is somewhat expanded again at the tuberosity.

FIG. 158.—SACRO-SCIATIC LIGAMENTS.

a. Large, and *b*, small.

and small ;

The *small* or *anterior ligament* (fig. 158, *b*) is attached internally by a wide piece to the border of the sacrum and coccyx, where it is united with the origin of the preceding band. The fibres are directed outwards, and are inserted as a narrow band into the ischial spine of the hip-bone. Its deep surface is blended with the coccygeus ; and it may be looked upon as being a fibrous portion of that muscle. Above it is the large sacro-sciatic foramen ; and below it is the small foramen of the same name, which is bounded by the two ligaments.

apertures formed by them ;

By their position these ligaments convert into two foramina (sacro-sciatic) the large sacro-sciatic excavation in the dried bones : the openings, and the structures they give passage to, have been described with the buttock (p. 124).

Use. The sacro-sciatic ligaments, by holding down the lower part of the sacrum, serve to prevent that bone from rotating at the ptero-iliac articulation, under the influence of the weight pressing on its upper end in the erect position.

Ilio-lumbar ligament :

The ILIO-LUMBAR LIGAMENT is a strong triangular band, which springs by its narrow end from the extremity of the transverse process of the fifth lumbar vertebra. Directed outwards and somewhat backwards, it spreads out to be inserted into the iliac crest for about an inch, opposite the back part of the iliac fossa. To the upper border of the ligament the anterior layer of the fascia

lumborum is attached; and its posterior surface is covered by the quadratus lumborum.

Use. This ligament supports the upright moveable portion of the spinal column, and resists the tendency of the last lumbar vertebra to slip forwards over the inclined base of the sacrum. use.

SACRO-ILIAC ARTICULATION. The irregular surfaces by which the sacrum and the hip-bone articulate are covered with cartilage, and are maintained in contact by anterior and posterior sacro-iliac ligaments. Inferiorly the bones are further connected, without being in contact, by the strong sacro-sciatic ligaments. Union of sacrum and hip-bone.

Dissection. To see the posterior ligaments, the mass of muscle at the back of the sacrum is to be removed on the side on which the hip bone remains. The thin anterior bands will be visible on the removal of some areolar tissue. The small sacro-sciatic ligament will be brought into view by removing the fleshy fibres of the coccygeus; and the large ligament has been dissected with the lower limb. To dissect the ligaments.

The *anterior sacro-iliac ligament* consists of a few thin scattered fibres between the bones, near their articular surfaces. Anterior ligament.

The *posterior sacro-iliac ligament* is very strong, and consists of bundles of fibres which pass obliquely from the rough part of the inner side of the ilium above the auricular surface to the depressions on the back of the first and second pieces of the sacrum. A distinct band, longer and more superficial than the rest, runs from the posterior superior iliac spine to the third and fourth pieces of the sacrum; it is named the *long posterior ligament.* Posterior ligament: a special long band.

Articular cartilage. This may be seen after the sacro-sciatic and ilio-lumbar ligaments have been examined, by opening the articulation and separating the bones. It covers the articular surfaces of both sacrum and ilium, but is much thicker on the sacrum. Its surface is generally uneven; and the intermediate cleft is sometimes partly interrupted by transverse fibres uniting the two layers. A layer of cartilage on each bone.

Mechanism. There is scarcely any appreciable movement in this articulation, owing to the tightness with which the two bones are bound together by ligaments, and the irregular form of the articular surfaces, which are consequently unable to glide over one another. In the erect posture the sacrum is suspended between the two hip-bones by the thick posterior sacro-iliac ligaments, and the upper arch of the pelvis is thereby rendered less rigid than would be the case if it were formed of continuous bone. The sacro-iliac articulation thus serves to give elasticity to the pelvis, and to diminish the effect of shocks passing to the spine. Use of joint is to render pelvis elastic.

PUBIC ARTICULATION (symphysis pubis; fig. 159, *a*). The two pubic bones are united by an interpubic disc, by ligamentous fibres in front and above, and by a strong subpubic ligament. Symphysis pubis.

The *anterior pubic ligament* is composed of interlacing fibres which are mixed with fibres of the tendon of the external oblique muscle. Anterior ligament.

There is not any definite posterior band; but the periosteum is thickened by a few scattered fibres. Few fibres behind

and above. The *superior ligamentous fibres* fill the interval betwcen the bones above the disc.

Subpubic ligament. The *subpubic ligament* (ligamentum arcuatum; fig. 159, *d*) is a strong triangular band occupying the angular interval between the pubic rami at the lower part of the symphysis. Its apex is continuous with the fibrous portion of the interpubic disc; its base is free and concave, and forms the summit of the subpubic arch.

How to show disc. **Dissection.** The disc will be best seen by making a transverse

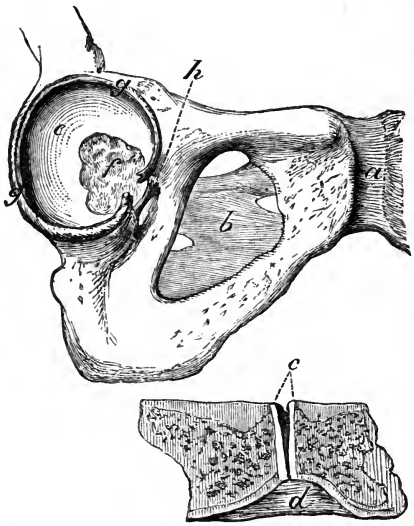


Fig. 159.—Ligaments of the Symphysis Pubis, Thyroid Foramen, and Acetabulum.

a. Anterior ligament of the symphysis.
b. Obturator membrane.
c. Interpubic disc, with a slit in the middle.
d. Subpubic ligament.
e. Surface of the acetabulum covered with cartilage.
f. Fatty substance in the acetabulum ("gland of Havers").
g. Cotyloid ligament, which is cut where it forms part of the transverse band over the notch.
h. Deep part of the ligament over the cotyloid notch.

section of the bones, which will show the disposition of the anterior ligament of the articulation, and the thickness of the plate, with its toothed mode of attachment to the bone; and when another opportunity offers, a vertical section may be made.

Interpubic disc: The *interpubic disc* consists of a layer of cartilage on each side, which is firmly adherent to the ridged surface of the bone, and a fibrous portion in the middle. The fibrous part is thickest in

cleft in it. front; and at the upper and back portion of the symphysis there is generally a fissure, produced by the absorption of the fibrous

substance. In some bodies the fissure extends through the whole of the disc, so as to divide it completely into two.

Obturator membrane closes an aperture in front.

The thin OBTURATOR MEMBRANE (fig. 159, *b*) almost closes the thyroid foramen, and is composed of fibres crossing in different directions. It is attached to the bony margin of the foramen, except above where the obturator vessels pass through; and at the lower and inner part of the aperture it is connected to the pelvic aspect of the hip-bone. The surfaces of the ligament give attachment to the obturator muscles. Branches of the obturator vessels perforate it.

TABLE OF THE ARTERIES OF THE ABDOMEN.

THE ABDOMINAL AORTA gives off

1. Phrenic. . Superior capsular.
2. cœliac axis*
   - Coronary . . Œsophageal; gastric.
   - hepatic . . Gastro-duodenal . . Right gastro-epiploïc; superior pancreatico-duodenal.
     - pyloric
     - left hepatic branch
     - right hepatic branch . Cystic.
   - splenic . . pancreatic; vasa brevia; left gastro-epiploïc; splenic.
3. superior mesenteric.*
   - Inferior pancreatico-duodenal
   - intestinal
   - ileo-colic
   - right colic
   - midde colic.
4. middle capsular
5. renal . . Inferior capsular.
6. spermatic
7. inferior mesenteric*
   - Left colic
   - sigmoid
   - superior hæmorrhoidal.
8. lumbar
9. middle sacral*
10. common iliac.
    - External iliac . . Deep epigastric . . Pubic; cremasteric; muscular; cutaneous.
      - deep circumflex iliac.
    - internal iliac . . Parietal branches.
      - Ilio-lumbar
      - lateral sacral
      - gluteal . . Superficial; deep.
      - sciatic . . Coccygeal; comes nervi ischiadici; muscular; anastomotic.
      - internal pudic . . Inferior hæmorrhoidal; superficial perineal; transverse perineal; artery of the bulb; artery of corpus cavernosum; dorsal artery of penis.
      - obturator . . Iliac; pubic.
      - Visceral branches . . superior vesical; inferior vesical; middle hæmorrhoidal; vaginal; uterine.

* The branches marked with an asterisk are single.

TABLE OF THE VEINS OF THE ABDOMEN.

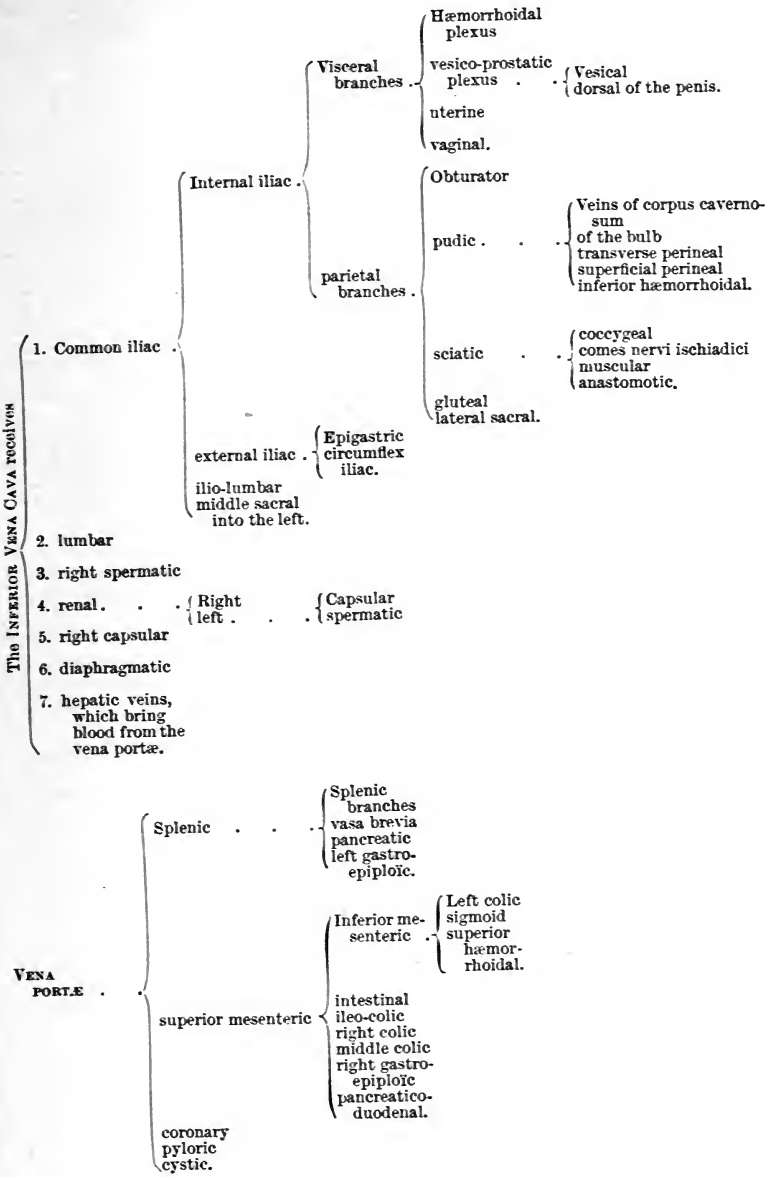


TABLE OF THE SPINAL NERVES IN THE ABDOMEN.

- **LUMBAR SPINAL NERVES divide into**
  - Posterior branches
    - Internal — Muscular; spinal.
    - external — Muscular; cutaneous.
  - Anterior branches: of these the four first end in the LUMBAR PLEXUS, which supplies
    - Ilio-hypogastric — Iliac branch; hypogastric branch.
    - ilio-inguinal — To integuments of the groin.
    - genito-crural — Genital branch; crural branch.
    - external cutaneous — To integuments of the thigh.
    - anterior crural
      - Branches inside the pelvis — To the iliacus muscle; to the femoral artery.
      - Branches outside the pelvis — are noticed in the thigh.
    - obturator — Accessory — Other offsets are described in the thigh.

- **SACRAL SPINAL NERVES divide into**
  - Posterior branches unite together and give off — Muscular and cutaneous filaments.
  - The anterior branches of the four superior unite with the lumbo-sacral in the SACRAL PLEXUS,* and furnish
    - Terminal branches
      - Great sciatic — described in the lower limb.
      - pudic
        - Inferior hæmorrhoidal
        - perineal — Superficial, internal and external muscular to the bulb.
        - dorsal of penis.
    - collateral branches
      - Superior gluteal; inferior gluteal; small sciatic — noticed in the lower limb.
      - perforating cutaneous
      - to pyriformis
      - to obturator internus and superior gemellus; to quadratus femoris and inferior gemellus — noticed in the buttock.
      - visceral
      - to levator ani
      - to coccygeus
      - to external sphincter.

* The other sacral nerves are described at p. 402.

TABLE OF THE SYMPATHETIC NERVES IN THE ABDOMEN.

- **Solar Plexus*** furnishes the following plexuses
  - Diaphragmatic
  - cœliac
    - Coronary plexus
    - hepatic
      - Pyloric
      - right gastro-epiploïc
      - pancreatico-duodenal
      - cystic.
    - splenic
      - Left gastro-epiploïc
      - pancreatic.
  - superior mesenteric — Offsets to small and large intestine.
  - suprarenal
  - renal — Spermatic plexus, filaments to the.
  - aortic — Hypogastric.
  - spermatic
  - inferior mesenteric
    - Offsets to the large intestine
    - superior hæmorrhoidal.

* This receives
- Great splanchnic nerves
- small splanchnic nerves
- offsets of right pneumo-gastric.

- **Hypogastric Plexus†** ends in the pelvic plexus on each side, which gives the following plexuses
  - Inferior hæmorrhoidal
  - vesical
    - Prostatic
    - cavernous
    - deferential
    - to vesiculæ seminales.
  - uterine
  - vaginal.

- **Ganglíated cord** of the sympathetic in the abdomen supplies
  - External branches — To the lumbar and sacral spinal nerves.
  - internal
    - To aortic plexus
    - to hypogastric plexus
    - to join round middle sacral artery
    - between the cords on the coccyx, in the *ganglion impar.*

† This is joined above by
- The aortic plexus
- filaments from the lumbar ganglia.

PNEUMO-GASTRIC NERVE IN THE ABDOMEN.

- **Pneumo-gastric**
  - Right
    - Coronary branches to the back of the stomach
    - filaments to join the cœliac and splenic plexuses.
  - left
    - Coronary branches to the front of the stomach.
    - branches to the hepatic plexus.

CHAPTER VIII.

DISSECTION OF THE THORAX.

Section I.

THE WALLS OF THE THORAX.

Dissection. The dissection of the thorax will be commenced on the fourteenth day of the dissection of the body, after the removal of the upper limbs.

In the first place the sternum, ribs and costal cartilages with the intervening structures, will be carefully cleaned, so that the walls of the chest may be examined, but the lateral and anterior branches of the intercostal nerves issuing between the ribs and cartilages should be carefully preserved. The portions of the pectoralis major and minor, serratus magnus, rectus abdominus, and the external and internal oblique muscles of the abdomen, will be taken away, at the same time noting again the extent of their attachments; the insertion of the scalenus posticus will also be cleaned off the second rib. The origin of the sub-clavicus from the first costal cartilage need not be removed. Finally, by arrangement with the dissectors of the abdomen and head and neck, the body will be turned on to either side for a few minutes to complete the cleaning of the ribs and intercostal muscles as far back as the transverse processes of the vertebræ.

Clean walls of muscles.

Preserve nerves,

The chest wall. The costal cartilages will now be clearly seen; the upper seven ribs join the sternum, the sixth and seventh being close together at the lower end of the gladiolus, and the eighth, ninth and tenth cartilages terminate by articulation with the lower border of the cartilage above. Some distance from their anterior ends, the seventh, eighth, ninth and tenth cartilages will be observed to send up a short process to articulate with a similar one passing downwards from the cartilage above. The extremity of the eleventh rib cartilage is free, and commonly forms the lowest point of the chest wall. The twelfth rib is often not more than two inches or so in length.

Termination of the

costal cartilages.

Form. The form of the chest is irregularly conical, with the apex above and the base below; and it may appear afterwards, should the student find the lungs collapsed, that it is only partly filled by the contained viscera, but during life the whole of the space is occupied by the expanded lungs. It is flattened on the sides, and on

Form in general;

on a cross section.

section, the cavity is seen to be diminished in the middle line by the prominent spinal column, on each side of which it projects backwards.

Boundaries. On the sides are the ribs with the intercostal muscles ; in front is the sternum ; and behind is the spine. Boundaries.

The base is constructed at the circumference by the last dorsal vertebra behind, by the end of the sternum in front, and by the ribs with their cartilages on each side ; while the space included by the bones is closed by the diaphragm. The diaphragm,

The base is wider transversely than from before backwards, and the diaphragm is convex upwards towards the chest ; though at certain spots it projects more than at others. Thus in the centre it is slightly lower than on each side, and is on a level with the base of the ensiform process. On the right side, forming a dome over the liver, it rises to a level with the upper border of the fifth rib near its junction with the cartilage ; and on the left it arches over the stomach to the corresponding part of the upper border of the sixth rib. From the lateral projections, the diaphragm slopes suddenly towards its attachment to the ribs, but more behind than before, so as to leave an angular interval between it and the wall of the chest. The level of the attachment of the diaphragm will be marked by an oblique line, over the side of the chest, from the base of the ensiform process to the eleventh dorsal spine ; but it differs slightly on the two sides, being rather lower on the left. form of surface, and height: its side level.

The apex of the thoracic cavity is continued higher than the osseous boundary, and reaches into the root of the neck. Its highest point is not in the middle line, for there the windpipe, œsophagus, blood-vessels and other structures lie, but it is prolonged on each side for one or two inches above the anterior end of the first rib, so that the apex may be said to be bifid. Each point projects between the scaleni muscles, and under the subclavian blood-vessels ; and in the interval between them lie the several objects passing between the neck and the thorax. Apex reaches into neck, is bifid: how bounded.

Dimensions. The extent of the thoracic cavity does not correspond with the apparent size externally ; for a part of the space included by the ribs below is occupied by the abdominal viscera ; and the cavity reaches upwards, as just stated, into the neck. Exterior size not that of cavity.

In consequence of the arched condition of the diaphragm, the depth of the space varies greatly at different parts. At the centre, where the depth is least, it measures generally from six to seven inches, but at the back about half as much again ; and the other vertical measurements may be estimated by means of the data given as to the level of the attachment of the diaphragm on the wall of the thorax. Depth varies: before ; behind ; on sides.

Alterations in capacity. The size of the thoracic cavity is constantly varying during life with the condition of the ribs and diaphragm in breathing. Size is altered in life ;

The horizontal measurements are increased in inspiration, when the ribs are raised and separated from one another, and are diminished in expiration as the ribs approach and the sternum sinks. transversely by movements of ribs ;

An alteration in depth is due to the condition of the diaphragm in depth by diaphragm,

in respiration; for the muscle descends when air is taken into the lungs, thus increasing the cavity; and it ascends when the air is expelled from those organs, so as to restore the previous size of the space, or to diminish it in violent efforts. But the movement of the diaphragm is not equal throughout, and some parts of the cavity will be increased more than others. For instance, the central tendinous piece, which is joined to the heart-case, moves but slightly; but the lateral, bulging parts descend freely, and increase greatly the capacity of each half of the chest below by their separation from the thoracic parietes.

but unequally.

Thorax lessened, how.

The thoracic cavity may be diminished by the diaphragm being pushed upwards by enlargement, either temporary or permanent, of the viscera in the abdomen; or by the existence of fluid in the latter cavity.

Dissection. The external intercostal muscle should now be carefully cleaned, care being taken to preserve the nerves and a thin aponeurosis (*anterior intercostal membrane*) which passes forwards from the muscle to the sternum at the front of the chest.

Intercostal muscles.

The INTERCOSTAL MUSCLES form two layers in each space, but neither occupies the whole length of the interval. The direction of the fibres is different in the two, those of the external muscle running very obliquely downwards and forwards, while those of the internal pass, although less obliquely, downwards and backwards.

Outer layer is deficient in front.

The *external muscle* consists of fleshy and tendinous fibres, and is attached to the margins of the ribs bounding the intercostal space. It extends from the tubercle of the upper rib behind to the end of the bone in front, except in the last two spaces, where the muscle is continued forwards between the cartilages. The thin *anterior intercostal membrane* takes the place of the muscle between the rib-cartilages.

Dissection of deeper muscle.

Dissection. The internal intercostal muscle will be seen by cutting through and removing the external intercostal and the membrane in one of the widest spaces, say the third.

Inner layer deficient behind.

The *internal intercostal muscle* passes from the inner surface of the rib above to the upper border of the one below internal to the attachment of the external intercostal muscle. It begins near the angles of the ribs behind, the upper muscles approaching more closely to the spine than the lower ones, and reaches to the extremity of the intercostal space at the sternum in front. The fibres of the lowest two muscles are continuous anteriorly with those of the internal oblique of the abdomen. One surface is in contact with the external muscle, and the intercostal vessels and nerves; and the other is lined by the pleura.

The hinder part of the muscles will be seen again in the dissection of the back and thorax.

Use of

Action. By the action of the intercostal muscles the ribs are moved in respiration.

outer muscles;

The *external intercostals* elevate the ribs and evert the lower edges, so as to enlarge the thorax in the antero-posterior and transverse directions: they come into play during inspiration.

The *internal intercostals* act in a different way at the side and fore part of the chest. of inner muscles,

Between the osseous part of the ribs they depress and turn in those bones, diminishing the size of the thorax; and they are brought into use in expiration. interosseous part,

Between the rib cartilages they raise the ribs, and are muscles of inspiration, like the outer layer. intercartilaginous part.

Dissection. The intercostal vessels and nerves at the sides and front of the chest are now to be examined. The intercostal arteries which run from behind forwards are small and are not easily dissected out except in a well-injected subject. The best guide to the intercostal nerve is the lateral cutaneous branch, and this should be gently pulled on and traced back to the parent trunk. The third and fourth spaces may be devoted to the particular examination of the nerves, and the fourth rib should be cut through at its junction with its cartilage in front and as far back at the side as possible, and the severed portion of rib shelled out from its internal periosteum, great care being taken not to injure the subjacent pleura. The nerve and its accompanying vessel should first be sought for far back between the intercostal muscles close to the rib above. Expose intercostal nerves and vessels. Remove a portion of rib.

The INTERCOSTAL NERVES now seen only in the anterior half of their extent, are the anterior primary branches of the dorsal nerves, and supply the wall of the thorax. Placed at first between the layers of the intercostal muscles below the corresponding artery, each gives off the lateral cutaneous nerve of the thorax about midway between the spine and the sternum. Then, much diminished in size, the nerve is continued onwards, at first in the substance of the internal intercostal muscle, and afterwards between that muscle and the pleura as far as the side of the sternum, where it ends as the anterior cutaneous nerve of the thorax. *Branches* supply the intercostal muscles, and the triangularis sterni. Intercostal nerves: course, termination, and branches.

The INTERCOSTAL ARTERIES which run from behind forwards between the ribs are derived from the thoracic aorta in the case of the nine lower intercostal spaces (these being known as the *aortic intercostal arteries*), and from the superior intercostal branch of the subclavian in the case of the upper two spaces. They lie with the nerves between the strata of intercostal muscles, and close to the upper rib bounding the space. Near the angle of the rib the artery gives off a *collateral* branch which is continued forwards along the edge of the rib below; and both it and the parent vessel anastomose in front with the *anterior intercostal* offsets of the internal mammary artery which run outwards. Intercostal arteries bifurcate:

A small *cutaneous offset* is distributed with the lateral cutaneous nerve of the thorax, and other branches are furnished to the thoracic wall. offsets.

Dissection. Make three saw cuts through the sternum, two transversely across, one opposite the middle of the first intercostal space, and the other between the junction of the sixth costal cartilages, and with a third cut divide the piece of sternum between the first two cuts longitudinally into two, taking care not to open Division of the sternum.

Dissection of internal mammary vessels.

the pleural sacs. To bring into view the triangularis sterni muscle and the internal mammary vessels, the left half of the sternum with the cartilages of the true ribs, except the first and seventh, are to be taken away with the intervening muscles; but the two ribs mentioned are to be left untouched for the benefit of the dissectors of the abdomen and of the head and neck. Small arteries to each intercostal space and the surface of the thorax, and the intercostal nerves are to be preserved. If the piece of sternum and the costal cartilages are divided and removed carefully these can be shelled off the subjacent structures without injury to them. The surface of the triangularis sterni will be apparent when the loose tissue and fat are removed.

Triangularis sterni: origin;

The TRIANGULARIS STERNI (fig. 160) is a thin muscle beneath the costal cartilages. It *arises* internally from the side of the ensiform process, from the back of the sternum as high as the third costal cartilage, and, usually, from the inner ends of the cartilages of the lower two or three true ribs. Its fibres are directed outwards, the upper ones also ascending considerably, and are inserted by fleshy slips into the true ribs except the first and last, at the junction of the bone and cartilage: some of the fibres frequently end in an aponeurosis in the intercostal spaces.

insertion;

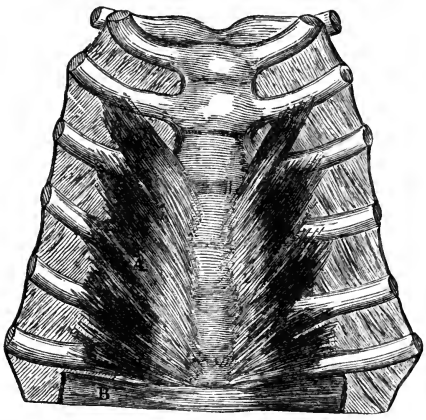


FIG. 160.—VIEW FROM BEHIND OF, A, TRIANGULARIS STERNI MUSCLE.

relations;

In front of the muscle are the rib-cartilages and the internal intercostals, with the internal mammary vessels and intercostal nerves. Behind, it lies on the pleura. Its lower part is continuous with the transversalis muscle of the abdomen (fig. 160, B). The size of this muscle varies greatly, and one or more of the upper slips are frequently wanting.

use.

Action. The triangularis sterni assists in depressing the anterior ends of the ribs, and acts with the interosseous part of the internal intercostals in expiration.

Internal mammary artery

The INTERNAL MAMMARY ARTERY is a branch of the subclavian, and enters the thorax beneath the cartilage of the first rib. It is continued through the thorax, lying behind the costal cartilages and about half an inch from the sternum, as far as the sixth intercostal space; here it gives externally a large muscular branch (*musculo-phrenic*), and then passing beneath the seventh cartilage, enters the sheath of the rectus muscle in the wall of the abdomen. In

courses through thorax to abdomen.

the chest the artery lies on the pleura and the triangularis sterni, and is crossed by the intercostal nerves. It is accompanied by two veins, and by the chain of sternal lymphatic glands. Its thoracic branches are numerous but small :— Branches:

a. A long, slender branch (*comes nervi phrenici*) arises as the artery enters the chest, and descends to the diaphragm with the phrenic nerve : this branch is seen in the dissection of the thorax. superior phrenic,

b. Small *sternal branches* supply the triangularis sterni, and ramify over the back of the sternum. From these, *mediastinal* twigs pass backwards to be distributed to the remains of the thymus gland and the pericardium. small posterior offsets,

c. Two *anterior intercostal branches* run outwards in each space, lying along the borders of the costal cartilages, and terminate by anastomosing with the aortic and superior intercostal branches. intercostal,

d. Perforating branches, one or two opposite each space, pierce the internal intercostal and large pectoral muscles, and are distributed on the surface of the thorax with the anterior cutaneous nerves : the lower branches supply the mamma in the female. perforating,

e. The *musculo-phrenic branch* courses outwards beneath the cartilages of the seventh and eighth ribs, and enters the diaphragm : it supplies anterior branches to the lower intercostal spaces. Its termination has been seen in the dissection of the abdomen. musculo-phrenic.

Two *veins* accompany the artery ; these join into one trunk, which opens into the innominate vein. Veins.

Section II.

THE CAVITY OF THE THORAX.

The cavity of the thorax is the space included by the spinal column, the sternum, and ribs, and by certain muscles in the intervals of the bony framework. In it the organs of respiration, and the heart with its great vessels are lodged ; and through it the gullet, and some vessels and nerves are transmitted. Definition. Contents of cavity.

Dissection. The soft parts should now be cleared away from between the ribs and cartilages on both sides, and the parietal layer of the pleura will then be seen adherent to their inner surfaces. Care should be taken, however, below the ninth rib not to remove portions of the diaphragm, as it lies here close to the chest wall, and the cavity of the thorax is there very narrow. The second, third, fourth, fifth and sixth ribs on the left side should then be divided as far back as possible, and taken away without opening the pleura beneath. Dissection to open thorax. Remove ribs on left side,

A longitudinal incision will then be made down the whole length of the exposed pleura, about midway between the vertebræ and the sternum, and small cross cuts will be made above and Open pleura.

below, so as to freely admit the hand into the pleural cavity. When the general cavity has been examined, the *anterior mediastinum*, or the space between the two pleural sacs behind the sternum and in front of the pericardium, will be cleared. With one hand in the pleural sac as a guide to its anterior limit, it will be found easy to mark the limits of the mediastinum, and the pleuræ can be readily separated in the middle line, and from the pericardium, which they overlap. The portion of sternum with the ribs and cartilages of the right side have been left on for the preservation of the anterior mediastinum, but after it has been examined the ribs should be removed on the right side as on the left, and the pleural sac opened and its limits defined. Finally the right half of the sternum with the attached costal cartilages will be removed and kept aside with the left portion for future examination. It, unfortunately, often happens in subjects for dissection, that the pleura is thickened and adherent to the lung. Should the dissector find it is so on the left side, he should at once open the right in case the membrane may be healthy on that side.

Open right side,

Sac of the pleura:

THE PLEURÆ are two serous membranes, or closed sacs, which are reflected around the lungs in the cavity of the thorax. One occupies the right, and the other the left half of the cavity; they approach each other along the middle of the chest, forming a thoracic partition or mediastinum.

form;

Each pleura is conical in shape; its apex projects into the neck above the first rib (fig. 162, p. 447); and its base is in contact with the diaphragm. The outer surface is rough, and is connected to the lung and the wall of the thorax by areolar tissue; but the inner surface is smooth and free. Surrounding the lung, and lining the interior of one half of the chest, the serous membrane consists of a parietal part, which is variously called—

outer surface; inner surface;

disposition.

1. *Costal pleura*, where it lines the chest-wall;
2. *Phrenic pleura*, where it covers the diaphragm;
3. *Pericardial pleura*, where it covers the pericardium; and
4. *Cervical pleura*, where it passes into the neck.

The visceral pleura is the *pulmonary pleura*.

Difference in sac of right,

and of left side.

There are some differences in the shape and extent of the two pleural bags. On the right side the bag is wider and shorter than on the left; and on the latter it is narrowed by the projection of the heart to that side.

The continuity is here traced

The continuity of the bag of the pleura may be traced horizontally from any given point, over the lung and chest wall, back to the same spot in the following manner:—Supposing the membrane to be followed outwards from the sternum, it lines the wall of the chest as far as the spinal column; here it is directed forwards to the root of the lung, and is then reflected over the viscus, as the visceral or *pulmonary* pleura, covering its surface, and extending into the fissures between the lobes. From the front of the root of the lung the pleura may be followed over the side of the pericardium back again to the sternum.

from wall of chest to lung

Below the root of the lung it forms a thin fold, the *ligamentum latum pulmonis*, which unites the inner surface of the lung to the side of the pericardium, and may be seen by enlarging the hole in the pleura and drawing the lower part of the lung out. The ligament then appears as a fold passing from the inner part of the lung to the pericardium and presenting a free lower border. At the upper part of the chest the pleura forms a dome over the apex of the lung, which may be revealed by drawing that part of the lung downwards. At this part the membrane is strengthened by the strong fascia of the neck (*Sibson's fascia*), which is attached to the inner border of the first rib and closely invests the vessels at the upper opening of the thorax.

broad ligament of the lung,

Sibson's fascia,

LINE OF PLEURAL REFLECTION. *Surface marking.* The pleural cavity extends upwards on each side in the neck, two inches above the anterior part of the first rib, or an inch above the middle of the clavicle, where the shoulder is depressed. From this point the anterior limit of the sac extends downwards and outwards, reaching the middle line at the lower part of the manubrium sterni, and continues down in that line, or a little to the left thereof.

Surface marking;

On the *left side*, opposite the fourth costal cartilage, it passes outwards until clear of the sternum, and then passes downwards along its left side to the back of the sixth costal cartilage, thus presenting a notch, in which the pericardium comes into contact with the lower part of the sternum; but the notch is much less than that formed by the corresponding part of the lung (fig. 162). The pleura is connected by fascial bands to the upper surface of the diaphragm, and the line of its reflection passes in succession behind the sixth and seventh costal cartilages, reaching the junction of the eighth rib, with its cartilage in the lateral line. From this point it extends round the body, crossing the lower border of the tenth rib in a line midway behind the vertebræ behind and the middle line in front. This is usually the lowest part of the pleural cavity, and from here it extends backwards to the inner surface of the twelfth rib, and, quite commonly, it projects below the twelfth rib under the external arched ligament of the diaphragm. It is most important to bear this fact in mind in operations on the posterior abdominal wall, so as to avoid opening the pleural sac.

left side,

præcordial notch;

projection under twelfth rib

On the *right side* the line of the pleural reflection is the same as on the left, except that it does not present a notch behind the sternum, where it overlaps the pericardium, but continues directly downwards on the middle line until it reaches the seventh costal cartilage, behind which its line of reflection passes outwards and downwards as on the left side.

on right side,

THE MEDIASTINUM. The median thoracic partition, or *mediastinum*, is formed by the inner portion of the parietal pleura on each side, and the structures interposed between the two membranes. It extends the whole depth of the thorax, and reaches mesially from the spine to the sternum, thus separating the right and left pleural cavities. In the centre the two layers of serous membrane are widely separated by the heart; but in front and

Along middle the sacs form a septum.

behind they come nearer together. The partition is artificially divided into four parts, which are distinguished as the superior, anterior, middle, and posterior mediastina.

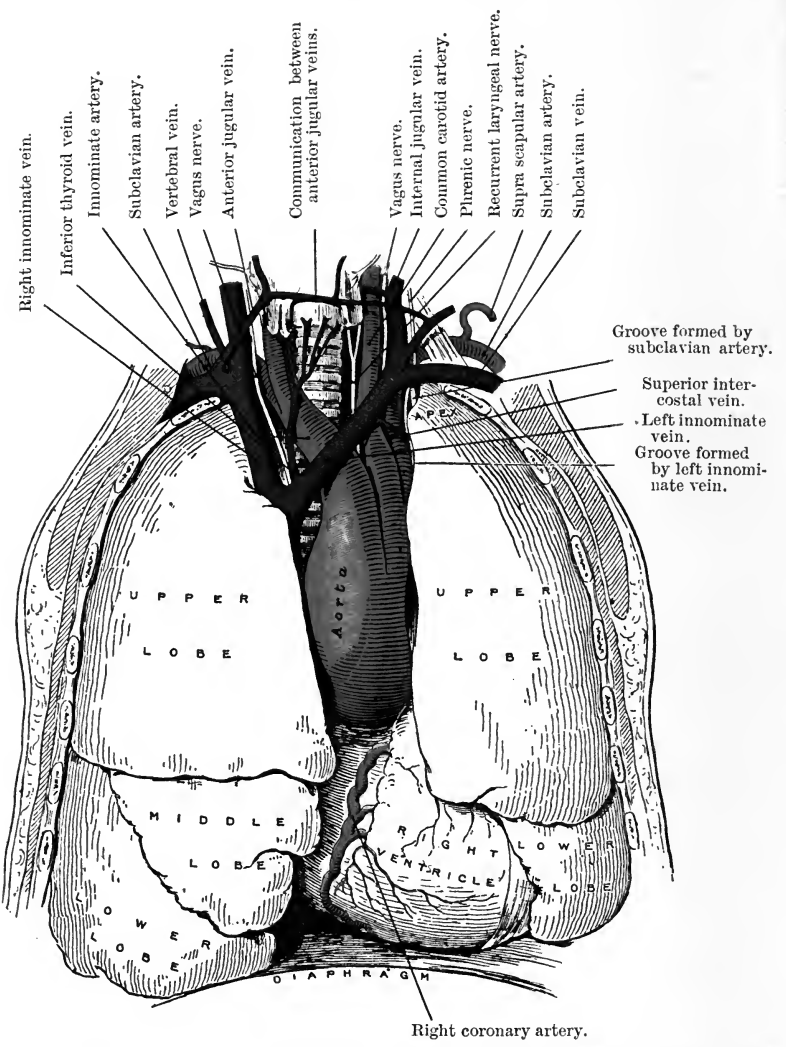


FIG. 161.—THE CONTENTS OF THE THORAX SEEN FROM THE FRONT. THE LUNGS WERE FILLED WITH MELTED WAX AND WERE HELD APART IN FRONT UNTIL THE WAX HAD SET. (FROM A SPECIMEN IN CHARING CROSS HOSPITAL MUSEUM.)

Superior mediastinum: boundaries,

The *superior mediastinum* is the part of the thoracic chamber above the pericardium, and may be defined as bounded below

by a plane extending from the lower border of the body of the fourth dorsal vertebra to the junction of the manubrium with the body of the sternum. It is limited in front by the manubrium with the origins of the sterno-hyoid and sterno-thyroid muscles, and behind by the upper four dorsal vertebræ and the lower ends of the longi colli muscles. Between the pleuræ in this part there are found, proceeding from before backwards, the following objects : and contents. —the remains of the thymus gland, several lymphatic glands, the innominate veins (fig. 162), and the upper half of the superior cava, the phrenic and pneumo-gastric nerves, the arch of the aorta with its three large branches, innominate, left carotid and left subclavian, the trachea, œsophagus and thoracic duct, and the left recurrent laryngeal nerve.

The *anterior mediastinum* is the space in front of the pericardium between the pleuræ, and is very narrow in its upper half, since the two pleuræ meet behind the sternum from the level of the second to the fourth costal cartilages. Below the latter spot the left pleura inclines away from the middle line, and is separated from its fellow by an interval in which the pericardium comes into contact with the sternum and the left triangularis sterni muscle. This contents. mediastinum contains only some areolar tissue, with a few small lymphatic glands. In some bodies the left pleura is continued behind the sternum nearly as far as the diaphragm. Anterior mediastinum is the smallest :

The *middle mediastinum* is the largest part of the central space, and includes the pericardium with the contained heart and great vessels, viz., the ascending aorta, the trunk of the pulmonary artery, and the lower half of the superior vena cava ; also the phrenic nerves, the roots of the lungs with the bronchial lymphatic glands, and, on the right side, the arch of the azygos vein. Middle mediastinum : contents.

The *posterior mediastinum* is the portion between the pericardium and the spine ; and the interpleural space is here larger than in front of the heart. Its extent and contents will be shown later, but it may be here said that enclosed between the serous layers boundaries, of the posterior mediastinum (fig. 174, p. 481) are the descending and contents. thoracic aorta, the azygos veins, the œsophagus with the pneumo-gastric nerves, and the thoracic duct, as well as a set of lymphatic glands. Posterior mediastinum :

Dissection. The pleuræ and the fat are now to be cleaned from the sides of the pericardium. Clean pericardium and

The *root of the lung* is to be dissected out by taking away the pleura and the areolar tissue from the front and back without injuring its component vessels. To clean the back of the root, the lung should be thrown forwards to the opposite side of the chest. In this dissection the phrenic nerve and artery will be found in front of the root, together with a few small anterior pulmonary nerves ; the last are best seen on the left side. Behind the root of the lung is the vagus nerve, dividing into branches ; and arching above the right one is the large azygos vein. the root of the lung. Trace the nerves. and azygos vein.

For the present, the arch of the aorta and the small nerves on it may be left untouched.

Thymus body in fœtus:

The THYMUS GLAND is an organ which is most developed in the infant, and the use of which is not understood. It is placed mainly in the upper part of the thorax; and it may be best examined in a full-grown fœtus.

size and extent.

At birth it is about two inches in length, and of a greyish colour. It consists of two lobes of a conical form, which touch each other. Its upper end is pointed, and extends on the trachea as high as the thyroid body; and the lower, wider, part reaches as far as the fourth rib. In the thorax it rests on the aortic arch and its large branches, on the left innominate vein and on the pericardium.

Remains in adult.

In the young adult all that remains of the thymus is a brownish rather firm material in the interpleural space behind the upper end of the sternum; and after middle life it has generally disappeared altogether.

RELATIONS OF THE LUNGS.

Number and use.

The lungs are two in number, and are contained in the cavity of the thorax, one on each side of the spinal column. In these organs the blood is changed in respiration.

Form and parts.

Each lung is of a somewhat conical form, and takes its shape from the space in which it is lodged. It is unattached, except at the inner side where the vessels enter forming the root; and it is covered by the bag of the pleura. It has a base and apex, two borders and two surfaces. Two fissures on the right and one on the left divide it into lobes.

Base touches diaphragm: shape and level.

The base of the lung is hollowed in the centre and thin at the circumference, fitting the convexity of the diaphragm. Following the shape of that muscle, it is sloped obliquely from before backwards, and reaches in consequence much lower behind than in front.

Surface marking (fig. 162). The position of the lower border with respect to the wall of the thorax may be roughly indicated by a line drawn from the sixth chondro-sternal articulation with a slight convexity downwards to the tenth dorsal spine; but it will be slightly lower in front on the left, than on the right side. The *apex* is rounded, and projects from one to two inches above the anterior end of the first rib, where it lies beneath the clavicle, the anterior scalenus muscle, and the subclavian artery.

Apex is in the neck.

Anterior edge is thin position on right, and left side.

The *anterior border* is thin, and overlies in part the pericardium. *On the right side* it lies along the middle of the sternum as low as the sixth costal cartilage. *On the left side*, however, it reaches, like the pleura, along the middle line only as low as the fourth costal cartilage. Below that spot it presents a V-shaped notch the apex of which is opposite the outer part of the cartilage of the fifth rib. Below the notch the lung extends inwards behind the outer part of the sixth costal cartilage, and the lower border passes round the chest, on the left as well as on the right sides, crossing the seventh rib in the lateral line and the ninth rib when it is half way round the body, and it is roughly at that part a rib and an intercostal space above the line of pleural reflection.

The *posterior* border is half as long again as the anterior, and projects inferiorly between the lower ribs and the diaphragm; it is thick and vertical, and is received into the hollow by the side of the spinal column. Posterior edge is thick.

The outer surface of the lung is convex, and is in contact with the wall of the thorax: a large cleft, known as the *great fissure*, divides it into two parts, and on the right side there is an additional smaller fissure. The inner surface is flat when compared with the outer: at the fore part is a large hollow which lodges the heart and great vessels, and is most marked on the left lung; and behind this is a depression about three inches long, *hilum pulmonis*, which gives attachment to the root. External surface. Internal surface

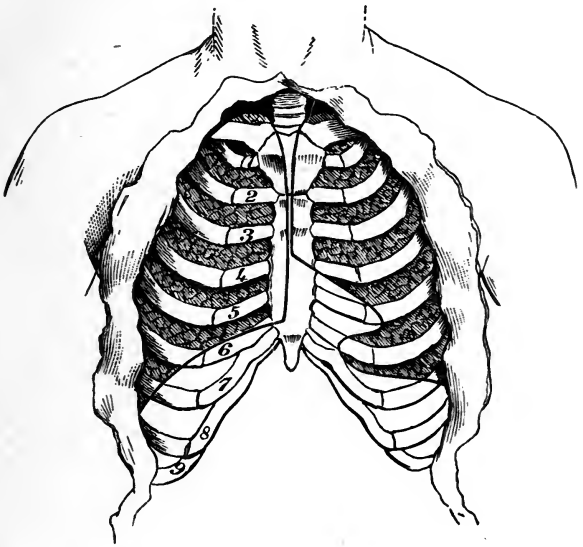


FIG. 162.—DIAGRAM TO SHOW THE DIFFERENCE IN THE ANTERIOR BORDER OF THE RIGHT AND LEFT LUNG, THE EDGE BEING INDICATED BY THE DARK LINE; AND TO MARK THE DIFFERENT LEVEL OF THE BASE ON THE TWO SIDES.

receives the vessels of the root of the lung. In the hardened specimen well-marked grooves are seen upon the lung for the reception of the great vessels with which it is in contact, and on the left lung is a specially deep groove in its inner surface formed by the arch of the aorta, and by the descending thoracic aorta (fig. 163, p. 448).

Each lung (fig. 161) is divided into two lobes by the *great fissure*, which, running obliquely downwards and forwards, begins at the posterior border near the apex, and ends at the fore part of the base, and the lower lobe of the lung is larger than the upper. In the right lung a second *horizontal fissure* is directed forwards from the middle of the oblique one to the anterior border, and cuts off a small Division into lobes. Left has two, and the right three lobes.

triangular piece from the upper lobe, which is called the middle lobe. Occasionally there may be a trace of the third lobe in the left lung.

Surface marking of the fissures.

The *surface marking* for *the great fissure* of the lung is a line taken downwards and forwards round the chest from the middle line of the back behind opposite the root of the spine of the scapula, to the junction of the sixth rib with its cartilage in front and below. The *horizontal fissure* of the right lung is marked by a line

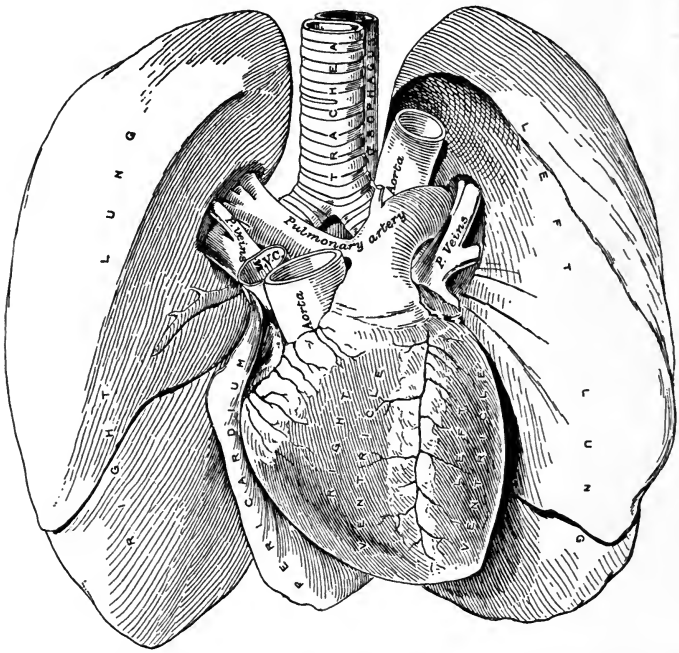


Fig. 163.—The Roots of the Lungs from the Front. The Lungs were separated from one another, the greater part of the Arch of the Aorta cut away, and the Heart drawn down.

drawn outwards from the middle of the sternum opposite the fourth costal cartilage until it meets the line of the great fissure.

Difference in form and size of the lungs.

Besides the difference in the number of the lobes, the right lung is larger and heavier, and is wider and more hollowed out at the base, as well as being somewhat shorter than the left. The increased length and the narrowness of the left lung are due to the absence of a large projecting body like the liver below it, and to the direction of the heart to the left side.

Root of the lung:

The root of the lung (fig. 163) consists of the vessels entering the fissure on the inner surface; and as these are bound together by the pleura and some areolar tissue they form a stalk, which

situation;

attaches the lung to the heart and windpipe. The root is situate

at the inner surface, about midway between the base and apex, and about a third of the way from the posterior to the anterior border of the lung.

In front of the root on both sides are the phrenic and the anterior pulmonary plexus of nerves, the phrenic nerve being some little distance from it upon the side of the pericardium. Anterior to the root of the right lung also is the superior vena cava. *Behind* on both sides is the posterior pulmonary plexus; and on the left side there is, in addition, the descending aorta. *Above*, on the right side, is the great azygos vein; and on the left side, the arch of the aorta. *Below* each root is the fold of pleura called the ligamentum latum pulmonis. relations.

In the root of the lung are collected a branch of the pulmonary artery, two pulmonary veins, and a division of the air tube (bronchus), as well as small nutritive bronchial arteries and veins, and some nerves and lymphatics. The large vessels and the air tube have the following positions to one another:— Constituents of the root;

On both sides the bronchus is on a posterior plane, and the pulmonary veins are lowest down on the most anterior plane, and the pulmonary artery is intermediate. On the *right side* the uppermost branch of the bronchus occupies the highest place, and the remainder of the bronchus is directed downwards and outwards behind the blood vessels, the pulmonary artery is next highest and the veins are lowest down. On the *left side* the pulmonary artery occupies the highest place with the veins below it, within its concavity, and being anterior to the artery at their emergence from the lung; the bronchus is directed downwards and outwards behind the vessels, and is intermediate in level. This difference in the two sides is accounted for by the fact that the bronchus of the right side gives off its branch to the upper lobe of the lung before it is crossed by the artery; while on the left side there is no corresponding branch of the airtube, and the artery crosses the undivided bronchial stem. their relative positions; differences in the two sides.

THE PERICARDIUM.

The bag containing the heart is named the pericardium. It is situate in the middle of the thorax, in the interval between the two pleuræ. Pericardium.

Dissection. The surface of the pericardium should now be cleaned, and the student should dissect out the large vessels above the heart, and trace the nerves (fig. 161, p. 444). Clean vessels of heart.

In cleaning the fibrous pericardium it will be noticed that bands connect it with the back of the upper and lower portions of the sternum still remaining—the superior and inferior *sterno-pericardial* ligaments.

The large artery curving to the left above the pericardium is *the aorta*, which furnishes three trunks to the head and the upper limbs, viz., from right to left, the innominate, the left common First aorta,

carotid, and left subclavian. On its left side of the aorta, and within the concavity of its arch, is the *pulmonary artery.*

then innominate veins

Above the arch of the aorta a large venous trunk, *left innominate*, crosses over the three arteries mentioned above, and ends by uniting on the right side with the right innominate vein in the upper cava. Several small veins, which may be mistaken for nerves, ascend over the aorta, and enter the left innominate.

and tributaries,

Define the tributaries of this vein, and especially one crossing the aortic arch towards the left side, which is the *left superior intercostal vein.* The *inferior thyroid vein,* which descends in front of the trachea to open into the left innominate vein or into the junction of the two innominate veins, should also be dissected out.

and upper cava.

The large vein by the side of the aorta is the *superior vena cava;* and the *azygos major vein* will be found opening into it behind, above the aorta of the right lung.

The *phrenic nerves* should be cleared on both sides from their entry into the thorax behind the subclavian veins above, along the side of the pericardium to the diaphragm below, as well as the *left vagus nerve*, which lies deeply upon the aortic arch, and will be found coming downwards in front of that vessel from between the origin of the left common carotid and subclavian arteries. Between

Nerves.

the left phrenic and vagus nerves and close to the aorta are the left superficial cardic nerve of the *sympathetic*, and the lower cervical cardiac branch of the left vagus; of the two, the last is the smaller, and in front of the other.

Dissect superficial plexus in arch of aorta.

The *cardiac nerves* from the left vagus and sympathetic are to be followed to a small plexus (superficial cardiac) in the concavity of the aorta. An offset of the plexus is to be traced downwards between the pulmonary artery and the aorta towards the right coronary artery of the heart; and another prolongation is to be found coming forwards from the deep cardiac to the superficial plexus; this dissection is difficult, and requires care.

When the pericardium is afterwards opened the nerves will be followed on the heart.

Pericardium: size and form;

The PERICARDIUM is somewhat conical in form, the wider part being turned towards the diaphragm, and the narrower part extending upwards beyond the heart on the large vessels. It is

position;

placed behind the sternum, and projects on each side of that bone, but much more towards the left than the right side. Laterally the pericardium is covered by the pleura, and the phrenic nerve and

relations.

vessels lie between the two. Its anterior surface is separated from the chest-wall by the pleuræ and lungs, except over the small area on the left side corresponding to the lower part of the anterior mediastinum; and behind, in the interval between the pleuræ, it is in contact with the œsophagus and aorta.

Composition.

The heart-case consists of a fibrous structure, which is lined internally by a serous membrane.

Fibrous part gives sheaths to vessels.

The *fibrous part* surrounds the heart, and is pierced by the large vessels joining that organ; and, with the exception of the inferior

cava, it gives prolongations along the vessels, the strongest of which is on the aorta.

Below the pericardium is united to the central tendon of the diaphragm, and extends a little over the muscular tissue, especially on the left side. For the most part it can be readily separated from the diaphragm, but in the median part of the central tendon it is firmly adherent, and the intimate association of the diaphragm, the back part of the pericardium and the roots of the lungs through the ligamentum latum pulmonis should be noticed.* The inferior vena cava pierces the pericardial attachment below, and, immediately entering the lower part of the right auricle, does not receive a sheath from the pericardium. In front, the pericardium is loosely connected to the back of the sternum in the superior mediastinum through the sterno-pericardial ligaments already noticed. The extent of its investments of the vessels entering or leaving the heart will be better seen when it is opened. It can now be seen that it is thickest at the upper part, and is formed of fibres crossing in different directions, many being longitudinal, and it can be traced up on to the large vessels at the opening of the thorax, and by pulling upon it, it will be seen that it is connected with the fascia at the root of the neck.

Attachment to diaphragm; to sternum; to fascia of the neck.

Dissection. The pericardium should now be opened by a longitudinal incision running its whole length from the front of the aorta, and by a cross cut passing from the front of the root of one lung to that of the other.

The *serous sac* consists of parietal and visceral parts, which are continuous with one another along the great vessels. The parietal part lines the fibrous membrane, with which it is inseparably united, and the included portion of the diaphragm; while the visceral part covers the heart. It is reflected around the pulmonary artery and aorta, enclosing them in one sheath, but not passing between them. The passage, through which the finger should be passed from side to side behind the aorta and pulmonary artery within the sac, is called the *transverse sinus of the pericardium*. The superior vena cava and the four pulmonary veins are only covered by the serous membrane on the front and sides, and are in contact with the fibrous layer behind. If the apex of the heart be lifted upwards to the right, at the back of the left auricle the serous membrane will be seen to form a blind pouch between the pulmonary veins of the two sides. This pouch is known as the *oblique sinus of the pericardium*.

Serous layer lines fibrous, and covers heart; disposition over vessels; transverse sinus; oblique sinus;

In front of the root of the left lung the serous layer forms a small triangular fold, the *vestigial fold of the pericardium* (Marshall), between the pulmonary artery and the upper pulmonary vein. This includes the remains of a left superior cava which existed in the fœtus, and, like the oblique sinus, can be seen by lifting the heart over to the right side.

vestigial fold.

The *vessels* of the pericardium are derived from the aorta, the internal mammary, the bronchial, the œsophageal and the phrenic arteries.

Vessels.

* See a paper by Keith on "The Nature of the Mammalian Diaphragm and Pleural Cavities."—*Journal of Anat. and Phys.*, vol. xxxix., 1905.

Nerves. *Nerves.* According to Luschka the pericardium receives nerves from the phrenic, sympathetic, and right vagus.

THE HEART AND ITS LARGE VESSELS.

The heart is hollow. The heart is a hollow muscular organ by which the blood is propelled through the body. Into it, as the centre of the vascular system, veins enter; and from it the arteries issue.

Form: anterior surface; *Form* (figs. 164 and 165). The heart is conical in form, but somewhat compressed from before backwards. The *anterior surface*, formed by the right ventricle and portions of the right auricle and

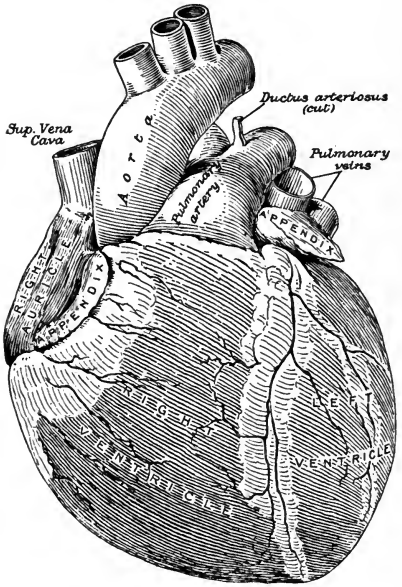


FIG. 164.—THE HEART SEEN FROM THE FRONT AND THE LEFT SIDE. THE DUCTUS ARTERIOSUS IS CUT ACROSS AND THE AORTA LIFTED UP TO SHOW THE RIGHT BRANCH OF THE PULMONARY ARTERY.

(From a specimen in Charing Cross Hospital Museum).

inferior surface; posterior surface; the left ventricle, is convex; the *inferior surface*, where it rests on the diaphragm, is formed by a great part of the left and a portion of the right ventricle, and is nearly flat; the *posterior surface*, formed by the left auricle and portions of the left ventricle and right auricle, is nearly flat and somewhat quadrilateral in outline.

left border; right border. The left border, formed by the left ventricle, is thick and rounded; while the right, formed by the right auricle and a portion of the ventricle, is thin and less firm.

Size and weight. *Size.* The size of the heart varies greatly; and it is usually smaller in the woman than in the man. Its average measurements may be said to be about five inches in length, three inches and

a half in width, and two and a half in thickness. Its weight is generally from ten to twelve ounces in the male, and from eight to ten in the female.

Position and direction. The heart lies behind the body of the sternum, and projects on each side of that bone, but more to the left than the right. Its axis is directed very obliquely, from behind forwards and to the left, as well as somewhat downwards. The base, or posterior surface, is towards the spine, being opposite the sixth, seventh and eighth dorsal vertebræ, and looks backwards and upwards. The apex strikes the wall of the chest during life in the fifth intercostal space of the left side, opposite the junction of the ribs with their cartilages. The anterior surface looks forwards and

Situation in the chest.

Base;

apex;

surfaces;

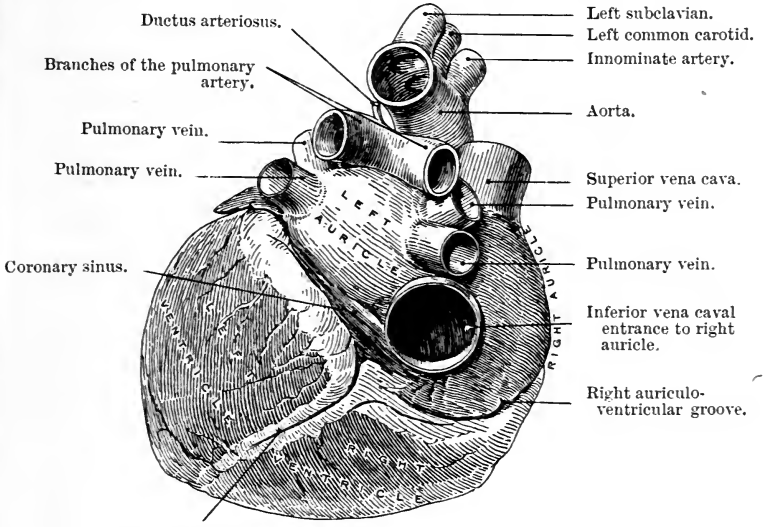


FIG. 165.—THE HEART SEEN FROM BEHIND AND BELOW.
(From a specimen in Charing Cross Hospital Museum).

somewhat upwards; while the inferior surface is nearly horizontal, resting on the diaphragm. The right margin is turned to the front; and the left is placed farther back.

borders;

In consequence of the oblique position of the heart, the right half and the apex are directed towards the thoracic wall, though mostly with lung intervening; while the left half is undermost and deep in the cavity.

right and left halves.

Surface marking (fig. 166). The extent of the heart in relation to the front of the chest may be indicated as follows:—The upper limit is marked by a line across the sternum from the lower edge of the second costal cartilage of the left side to the upper edge of the third cartilage of the right side; and the lower limit by a line,

Extent of the heart upwards,

downwards, slightly convex downwards, from the seventh chondro-sternal articulation of the right side to the apex in the fifth left interspace just below the costo-chondral junction, the latter point being usually about one inch and a half below, and three-quarters of an inch to the sternal side of the nipple in the male and, before child-bearing, to right in the female. On the right side the heart projects about one inch and a half from the middle line of the sternum; and on the left, and left. the apex is distant from three to three and a half inches from the centre of the breast-bone.

Superficial portion of heart. The portion of the heart which is uncovered by lung (*the area of*

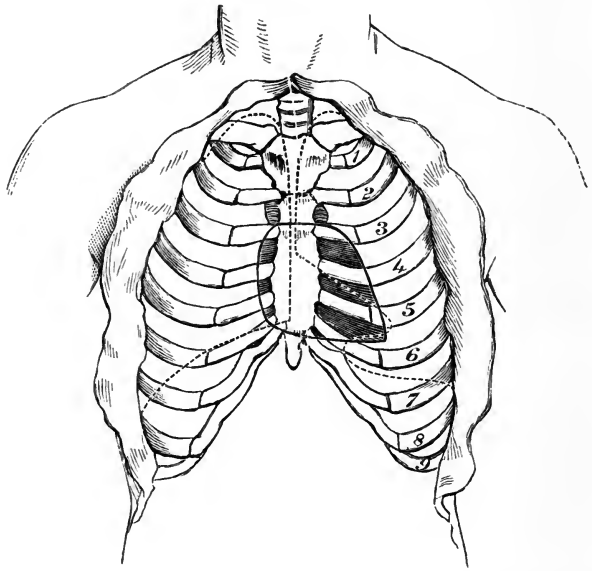


Fig. 166.—Diagram showing the Position of the Heart to the Ribs and Sternum, the Soft Parts being removed from the Exterior of the Thorax. The Edge of each Lung is shown by a Dotted Line. The Left Auricle extends somewhat higher than the Area indicated in the Figure, Projecting into the Second Intercostal Space.

superficial cardiac dulness) is included between the middle line of the sternum, in its lower third, and a line drawn from the centre of the breast-bone between the fourth costal cartilages to the apex of the heart (fig. 166).

Chambers of heart. *Component parts.* The heart is a double organ; and in each half there are two chambers, an auricle and a ventricle, which communicate together, and are provided with vessels for the entrance Grooves: and exit of the blood. The surface is marked by grooves indicating auriculo-ventricular, this division. Thus, passing circularly round the heart, nearer the base than the apex, is a groove which cuts off the thin auricular

from the fleshy ventricular part; and on each surface there is a longitudinal sulcus, usually occupied by whitish fat along the line of the coronary blood vessels, over the partition between the ventricles. The interventricular groove is nearer the left border of the heart in front, and nearer the right border behind. and interventricular.

The *auricles* are two, right and left, and their wall is much thinner than that of the ventricles. They are placed deeply at the base of the heart; and each is prolonged forwards into a small tapering part known as the *auricular appendix* or *auricle proper*, so called from its resemblance to a dog's ear. Auricles: position, and appendages.

The *ventricles* reach unequal distances on the two aspects of the heart:—thus the right one forms the lower part of the thin right border, most of the anterior and a part of the inferior surfaces; but the left enters alone into the apex, and constructs the left border, and the greater part of the inferior surface of the heart. Ventricles: right, and left

Dissection. Before opening the heart, the coronary arteries (*right* and *left*) are to be dissected on the surface, with the veins and small nerves that accompany them. The two arteries will be found surrounded by fat on the sides of the pulmonary artery, and run in the grooves on the surface of the heart, the right one being directed between the pulmonary artery and the right auricular appendix into the right auriculo-ventricular groove, and the left one between the pulmonary artery and the left auricular appendix into the left auriculo-ventricular groove. With each artery is a plexus of nerves, and that of the right side is to be followed upwards to the superficial cardiac plexus. Dissect coronary vessels and nerves,

In the groove between the left auricle and ventricle the student will find the large coronary vein, which passes to the back of the heart to empty into the dilated coronary sinus; and the last should be defined and followed to its ending in the right auricle (fig. 167). and coronary sinus.

The CORONARY ARTERIES are the first branches of the aorta, and supply the heart, one being distributed mainly on the right side, and the other on the left. Two arteries of the heart, viz.,

The *right artery* appears on the right side of the pulmonary trunk, and is directed backwards in the groove between the right auricle and ventricle, giving *branches* upwards and downwards to the walls of those chambers. Two of these are larger than the rest; one (*right marginal*) runs on the anterior surface of the right ventricle near the free margin; and the other (*posterior interventricular*) descends in the posterior interventricular furrow to the apex of the heart. A small branch is continued to the left side of the heart, lying in the hinder part of the left auriculo-ventricular groove. right coronary,

The *left artery* passes outwards behind the pulmonary trunk to the left side of that vessel, where it divides into two *branches*. Of these, the anterior is the larger (the *anterior interventricular*), and descends on the front of the heart in the groove between the two ventricles to the apex; while the posterior turns backwards between the left auricle and ventricle, giving *left marginal* and *posterior ventricular* branches. The branches of the two coronary arteries and left coronary: anastomoses.

communicate on the surface of the heart, but their anastomoses are very fine.

Cardiac veins.

The VEINS OF THE HEART (fig. 167) differ in their arrangement from the arteries, and are for the most part collected into one large trunk—the coronary sinus.

Coronary sinus: extent;

The *coronary sinus* (1) will be seen on raising the heart to be placed in the sulcus between the left auricle and ventricle. About an inch in length, it is joined at the left end by the *great cardiac vein* (4); and at the right end it opens into the right auricle. It is crossed by the muscular fibres of the left auricle. Inferiorly and at its right end it receives posterior cardiac branches from the back of the ventricles (††), and at its left extremity another small vein (2), the *oblique vein* (Marshall), which descends to it along the back of the left auricle.

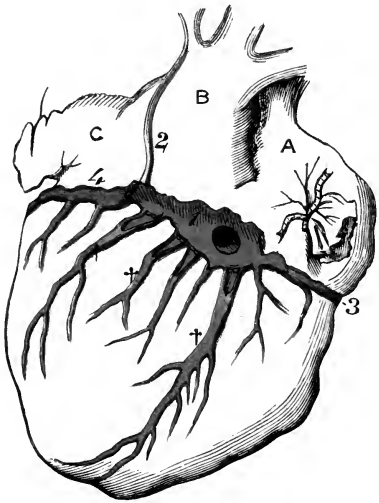


FIG. 167.—BACK OF THE HEART WITH ITS VEINS AND THE CORONARY SINUS. (MARSHALL).

A. Right auricle.
B. Left auricle, with the appendix, C.
1. Coronary sinus.
2. Oblique vein.
3. Right coronary vein.
4. Left or great coronary vein.
†† Posterior cardiac veins; the larger one on the right is the middle cardiac vein.

veins joining it;

valves.

On slitting up the sinus with the scissors the openings of its different veins will be seen to be guarded by valves, with the exception of the oblique vein; and at its right end is the Thebesian valve of the right auricle which will be seen later when the auricle is opened.

Large coronary vein.

The *left coronary* or *great cardiac vein* (4) begins in front near the apex of the heart, ascends in the interventricular groove, and then turns to the back in the sulcus between the left auricle and ventricle, to open into the coronary sinus (1). It receives branches, mainly from the left side of the heart, in its course; and its ending in the sinus is marked by a double valve.

Small coronary vein.

The *right coronary vein* (3) is of small size, and runs in the hinder part of the right auriculo-ventricular groove to the right end of the coronary sinus.

Posterior cardiac veins.

The *posterior cardiac veins* (††) ascend on the back of the left ventricle to the coronary sinus; and one larger vessel, the *middle cardiac vein*, lies in the posterior interventricular furrow.

Anterior cardiac veins.

The *anterior cardiac veins* are three or four in number, and run

upwards on the front of the right ventricle to open separately into the lower part of the right auricle.

Smallest cardiac veins. Other small veins lie in the substance of the heart, and are noticed in the description of the right auricle. Smallest veins.

CARDIAC NERVES. The nerves for the supply of the heart are derived from a large plexus (cardiac) beneath the arch of the aorta, from which offsets proceed to accompany the coronary arteries. The greater part of this plexus is deeply placed, and will be dissected at a later stage, but a superficial prolongation may now be seen. Nerves of heart.

The *superficial cardiac plexus* is placed below the arch of the aorta, to the right of the ductus arteriosus (fig. 164). The nerves joining it are the left superficial cardiac of the sympathetic, the lower cervical cardiac of the left vagus, and a considerable bundle from the deep cardiac plexus. A small ganglion is sometimes seen in the plexus. Inferiorly it sends off nerves along the right coronary artery to the heart. A few filaments also run on the left division of the pulmonary artery to the left lung. Superficial plexus ends in right coronary.

The *right coronary nerves* pass from the superficial plexus to the right coronary artery, and receive near the heart a communicating offset from the deep cardiac plexus. Coronary plexuses, right

The *left coronary nerves* are derived, as will be subsequently seen, from the deep cardiac plexus, and follow the left coronary artery. and left;

At first the nerves surround the arteries, but they soon leave the vessels, and becoming smaller by subdivision, are lost in the muscular substance of the ventricles. On and in the substance of the heart the nerves are marked by small ganglia. ending in the heart.

The CAVITIES OF THE HEART may be examined in the order in which the current of the blood passes through them, viz., right auricle and ventricle, and left auricle and ventricle. Four cavities of the heart.

Dissection. In the examination of its cavities the heart is not to be removed from the body. To open the *right auricle*, an incision should be made in it near the right or free border, extending from the superior cava nearly to the inferior cava; and from the centre of this cut the knife is to be carried across the anterior wall to the appendix. By this means an opening will be made of sufficient size; and on removing the coagulated blood, and raising the flaps with hooks or pieces of string, the cavity may be examined. Dissection to open right auricle.

The CAVITY OF THE RIGHT AURICLE (fig. 168) is of an irregular form,* though when seen from the right side, with the flaps held up, it has somewhat the appearance of a cone, with the base to the right and the apex to the left. Form of right auricle.

The widened part or *base* of the cavity is turned towards the right side, and at its extremities are the openings of the superior and inferior cavæ. Between those vessels the wall projects a little, and in some bodies presents a slight elevation (tubercle of Lower). The Its base

* The term cavity of the auricle is sometimes confined to the part in the appendix, and the name *atrium* or *sinus venosus* is then given to the rest of the space here named auricle.

and apex. *apex* is prolonged downwards towards the junction of the auricle with the ventricle, and in it is the opening into the right ventricular cavity.

Interior of appendix. The *anterior wall* is thin and loose. Near the top is an opening leading into the pouch of the appendix, which will admit the tip of the little finger. Near, and in the interior of the appendix, are prominent fleshy bands, named *musculi pectinati*, which run mostly in a transverse direction, and form a network that contrasts with the general smoothness of the auricle. The musculi pectinati, end upon a common ridge, the *crista terminalis*.

Crista terminalis.

The *posterior* (and *inner*) *wall* corresponds mostly with the septum

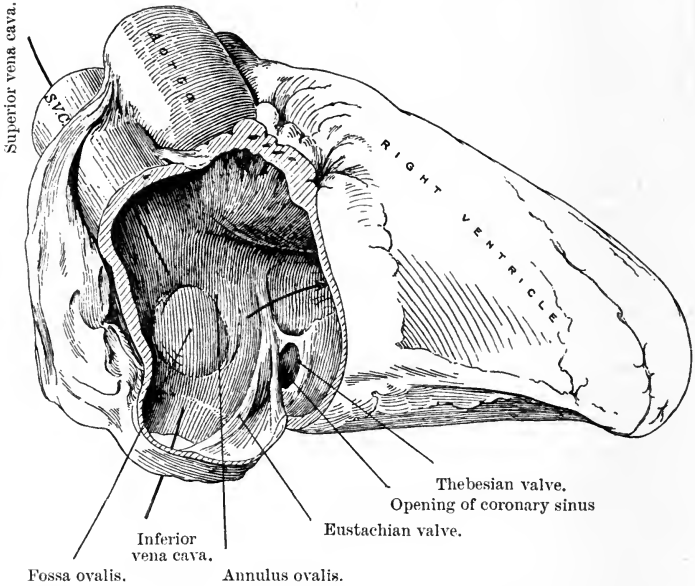


FIG. 168.—THE INTERIOR OF THE RIGHT AURICLE (FROM THE FRONT AND RIGHT); THE CURVED ARROW POINTS TO THE AURICULO-VENTRICULAR OPENING.

between the auricles. On it, opposite the opening of the inferior vena cava below, is a large oval depression, the *fossa ovalis*, which is the remains of an opening between the auricles in the fœtus. A thin semitransparent structure forms the bottom of the fossa; and there is oftentimes a small oblique aperture into the left auricle at its upper part. Around the upper three-fourths of the fossa is an elevated band of muscular fibres, called *annulus ovalis*, which is most prominent above and on the left side, and gradually subsides below.

Fossa ovalis.

Annulus ovalis.

Apertures of sinus At the lower end of the posterior wall, between the inferior caval and the auriculo-ventricular orifices, is the aperture of the

coronary sinus. Other small apertures, named *foramina of Thebesius*, are scattered over this surface; some lead only into depressions; but others are the mouths of veins of the substance of the heart (smallest cardiac veins). and smallest veins.

The chief *apertures* in the auricle are those of the two cavæ, coronary sinus, and ventricle. The opening of the superior cava is at the upper end of the auricle, and looks slightly forwards. The inferior cava enters the lowest part of the cavity at the back, close to the septum, and is directed inwards to the fossa ovalis. The auriculo-ventricular opening is the largest of all, and is situate at the lower and fore part of the cavity. Between this and the septum is placed the opening of the coronary sinus. Situation of cavæ, of auriculo-ventricular opening, of coronary sinus.

All the large vessels, except the superior cava, have some kind of valve. In front of the inferior cava is a thin fold of the lining membrane of the cavity, the *Eustachian valve*, which is only a remnant of a much larger structure in the fœtus. This fold is semilunar in form, with its convex margin attached to the anterior wall of the vein, and the other free in the cavity of the auricle. The valve is wider than the vein opening; and its surfaces are directed forwards and backwards: it is often cribriform. The aperture of the coronary sinus is covered by a thin fold of the lining membrane, which is prolonged internally on to the Eustachian fold, and is known as the *valve of Thebesius*. The auriculo-ventricular opening will be seen, in examining the right ventricle, to be provided with a tri-cuspid valve, which prevents the blood flowing back into the auricle. Valves of chief apertures: inferior cava has Eustachian valve; one to coronary sinus, and one to auriculo-ventricular opening.

In the adult there is but one current of blood in the right auricle towards the ventricle. But in the fœtus there are two streams in the cavity; one of pure, and the other of impure blood, which cross one another in early life. The placental or pure blood, entering by the inferior cava, is directed by the Eustachian valve into the left auricle, through the foramen ovale in the septum; while the current of systemic or impure blood, coming in by the superior cava, flows downwards in front of the other to the right ventricle. Course of blood in auricle in adult, and in the fœtus.

Dissection. To see the cavity of *the right ventricle*, the student should raise outwards a V-shaped flap of the anterior wall of the ventricle, as in fig. 169, the blunted apex of the V being below the root of the pulmonary artery, its upper border being parallel with, but about half an inch below, the auriculo-ventricular groove and the lower border being well to the right of the inter-ventricular furrow, so as to avoid injury of the inter-ventricular septum. In the examination of the cavity of the right ventricle, both the flap and the apex of the heart should be raised with hooks or string, so that the space may be looked into from below. To open right ventricle.

The CAVITY OF THE RIGHT VENTRICLE (fig. 169) is triangular in form, with the base turned towards the auricle of the same side. On a cross section it would appear semilunar in shape, the septum between the ventricles being convex towards the cavity. Cavity of right ventricle.

The *apex* of the cavity reaches the right border of the heart at Apex.

Base and its openings.

a short distance from the tip. The *base* of the ventricle is sloped, and is perforated by two apertures ; one of these, to the right and below, leading into the auricle, is the right auriculo-ventricular opening ; the other, on the left and much higher, is the mouth of the pulmonary artery. The part of the cavity leading up to the pulmonary artery is funnel-shaped, and is named the *infundibulum* or the *conus arteriosus.*

Anterior and posterior wall.

The *anterior wall*, or the loose part of the ventricle, is comparatively thin, and forms most of the anterior surface of the ventricular portion of the heart. The *posterior wall* corresponds with the septum between the ventricles, and is much thicker.

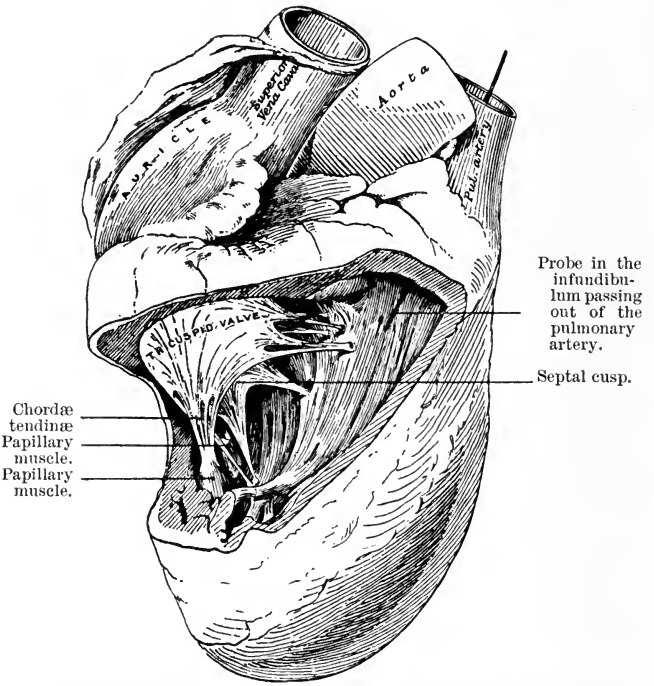


Fig. 169.—The Interior of the Right Ventricle (from the Front ; the Heart being held so that the Apex is Lowest Down).

Interior of the cavity is uneven; on it there are three sets of fleshy columns.

Over the greater part of the cavity the surface is marked by projecting muscular bands, the *columnæ carneæ* ; but near the aperture of the pulmonary artery the wall becomes smooth. The fleshy columns are of various sizes, and of three different kinds. Some form merely a prominence in the ventricle, especially on the septum. Others are attached at each end, but free in the middle (*trabeculæ carneæ*). And a third set, which are fewer in number and much the largest project into the cavity, and form rounded bundles,

named *musculi papillares*, which give attachment to the little tendinous cords of the valve of the auriculo-ventricular opening.

The *auriculo-ventricular orifice* is situate in the base of the ventricle, and behind the right half of the sternum, on a level with the fourth intercostal space. It is oval in shape, and measures about four inches in circumference, being slightly larger than the corresponding aperture of the left side. Opening from the auricle: position, form and size;

Fixed around the opening is a large membranous valve, which projects into the cavity of the ventricle. At its attached margin the valve is undivided: but its lower part is notched, so as to form three pendent cusps or tongues, whence the name *tricuspid* is given to it. Into the cusps are inserted small fibrous bands—the chordæ tendinæ, which unite them to the muscular wall of the ventricle. The three cusps are thus placed; one (*marginal*) is against the anterior wall of the ventricle; posteriorly, another (*septal*) touches the septum; and the third (*infundibular*), the largest and most moveable, is placed to the left, between the auriculo-ventricular opening and the infundibulum. is guarded by the tricuspid valve, Cusps: marginal; septal; infundibular.

The tricuspid valve consists of a duplicature of the lining membrane of the heart, enclosing fibrous tissue. The central part of each tongue is strong, while the edges are thin and notched; and between the main pieces there are often thinner intermediate points. Structure of valve;

The *chordæ tendinæ*, which keep the valve in place, ascend from the musculi papillares in the intervals between the cusps, and are connected in each space with the two pieces of the valve bounding it. They end on the surface of the cusps turned away from the opening, a few reaching the attached upper margin; but the greater number join the central thickened part, and the thin edge and point of the cusp. attachment by tendinous cords;

The papillary muscles are collected into two principal groups, an *anterior* sending its tendons to the marginal and infundibular cusps, and a *posterior*, to the marginal and septal cusps. In the interval between the infundibular and septal segments of the valve the tendinous cords are small, and spring from the septum. papillary muscles.

As the blood enters the cavity the valve is raised so as to close the opening into the auricle; and its protrusion into the latter cavity during the contraction of the ventricle is arrested by the small tendinous cords. The closure of this valve assists in producing the first sound of the heart.

The *mouth of the pulmonary artery* will be seen when the incision in the anterior wall of the ventricle is prolonged into it. The opening is circular, with a diameter of about an inch. It occupies the summit of the funnel-shaped portion of the ventricle, and is placed opposite the upper edge of the third costal cartilage of the left side, close to its junction with the sternum. Pulmonary orifice: size and position;

Pulmonary valve. Guarding the orifice of the pulmonary artery is a valve consisting of three semilunar or sigmoid flaps; a *right* and *left anterior*, and a *posterior*. Each flap is attached to the side of the vessel by its convex border, and is free at the opposite edge, in the centre of which there is a slightly thickened nodule—the its valve of three flaps;

dilatation of artery. *corpus Arantii*. In the wall of the artery opposite each flap is a slight hollow—the *sinus of Valsalva*.

Structure of valve; The valves are formed of fibrous tissue with a covering of the lining membrane. In each flap the fibres have the following arrangement: there is one band along the margin of attachment; a second runs along the free edge and is connected with the projecting nodule; and a third set of fibres is directed from the nodule across the flap, so as to leave a semilunar interval named *lunula* on each side near the free edge.

and use. The use of the valve is obvious, viz., to give free passage to fluid in one direction, and to prevent its return. While the blood is entering the artery the flaps are separated; but when the elasticity of the vessel acts on the contained blood they are thrown together in the centre of the vessel, and arrest the flow of the fluid into the ventricle. They are concerned in giving rise to the second sound of the heart.

To open left auricle. **Dissection.** To open the cavity of *the left auricle*, the apex of the heart is to be raised, and a cut is to be made across the posterior surface of the auricle from the right to the left pulmonary veins (see fig. 165, p. 453). Another short incision should be made downwards at right angles to the first. The heart must necessarily be held up during the examination of the cavity.

Form of cavity of left auricle. The CAVITY OF THE LEFT AURICLE is smaller than that of the right side, and is rather quadrilateral in shape, with its longest diameter directed transversely. It is joined at each side by the two pulmonary veins of that side: and at the lower and fore part it opens into the left ventricle.

Appendix and musculi pectinati. In the front wall, at the left extremity, is the opening of the appendix, which is longer and narrower than the corresponding part on the right side. Musculi pectinati are also present, but on this side they are usually confined to the appendix.

On septum remnant of foramen ovale. To the right of the opening into the appendix, on the part of the wall formed by the septum, is a superficial fossa, the remains of the oval aperture through that partition; this is bounded below by a projecting margin, concave upwards, which is the edge of the valve that closed the opening in the fœtus. This impression in the left auricle is above the fossa ovalis of the right cavity, because the aperture between the two in the fœtus was an oblique canal through the septum.

Openings: four pulmonary veins, and to ventricle. The *apertures* in this auricle are those of the four pulmonary veins, and the opening into the left ventricle. The mouths of each pair of pulmonary veins are close together; those from the right lung open into the extreme right of the auricle against the septum, and those from the left lung enter the opposite side of the cavity, near the appendix.

Valves. The pulmonary veins have no valves. The aperture into the ventricle will be subsequently seen to have a large and complicated valve to guard it, as on the right side.

Current of blood in adult; In the adult the blood enters this cavity from the lungs by the pulmonary veins, and flows into the left ventricle by the large

opening between the two. In the fœtus only a very small quantity of blood passes through the lungs; and the left auricle receives its pure blood from the inferior vena cava through the right auricle by the aperture in the septum (foramen ovale). in fœtus.

Dissection. The left ventricle may be opened by an incision along both the anterior and the posterior surfaces, near the septum; these are to be joined at the apex, but are not to be extended upwards so as to reach the auricle. On raising the triangular flap the interior of the cavity will be visible. How to open left ventricle.

The CAVITY OF THE LEFT VENTRICLE is longer and more conical in shape than that of the opposite ventricle; and it is oval, or almost circular, on a transverse section. Form of left ventricle.

The *apex* of the cavity reaches the apex of the heart. The *base* is turned towards the auricle; and in it are the openings into the aorta and the left auricle. Apex. Base with openings.

The *wall* of this ventricle is much thicker than that of the right, and the anterior boundary is formed for the most part by the interventricular septum. Wall.

Its *surface* is irregular, like that of the right ventricle, in consequence of the projection of the columnæ carneæ; but near the aorta the surface is smoother. There are three kinds of fleshy columns in this as in the right ventricle. The large *musculi papillares* give attachment to the tendinous cords of the auriculo-ventricular valve, and are more strongly marked than on the right side: they are arranged in two great bundles, which spring from the *right* and *left* sides of the cavity. Inner surface has fleshy columns, and some very large.

The *left auriculo-ventricular opening* is placed beneath the orifice of the aorta, but close to it, only a thin fibrous band intervening between the two. It is rather smaller than the corresponding aperture of the right side, being about three inches and a half in circumference, and it is longest in the transverse direction. It is furnished with a membranous valve (mitral) which projects into the ventricle. Left auriculo ventricular aperture: form and size;

The *mitral valve* is stronger and of greater length than the tricuspid, and has also firmer and more tendinous cords; it takes its name from a fancied resemblance to a mitre. Attached to a fibrous ring round the aperture, it is divided below by a notch on each side into two pieces. Its segments lie one before the other, with their edges directed to the sides, and their surfaces towards the front and back of the cavity. The *anterior*, or *aortic cusp*, of the valve intervenes between the auricular and aortic openings, and is larger and looser than the *posterior* or *marginal cusp*. Mitral valve: aortic cusp; marginal cusp;

The mitral resembles the tricuspid valve in its structure and office. Its segments consist of thicker and thinner parts; and in the notches at the sides there are also thinner pieces between the two primary segments. The chordæ tendinæ ascend to be attached to the valve in the notches between the tongues; and they end on the segments in the same way as in the tricuspid valve. Each of the large papillary muscles acts on both portions of the valve. structure; attachment of cords;

use. While the blood is entering the cavity, the cusps of the valve are separated; and when the ventricle contracts, they meet to close the passage into the left auricle. In combination with the tricuspid it assists in producing the first sound of the heart. The examination of the aortic opening will be deferred until the large vessels at the base of the heart have been studied; it is described on page 473.

Position of apertures SURFACE MARKING OF THE VALVULAR APERTURES. Two openings have been seen in each ventricle,—one of the auricle of its own side of the heart, and one of an artery.

of arteries, The apertures of the arteries (aorta and pulmonary) are nearest the interventricular septum; and as the two vessels were originally formed from one tube, they are close together; but of the two, the pulmonary artery is anterior and more to the left, as well as some-

pulmonary, what higher. As regards the surface the *pulmonary valve* is behind the junction of the third left costal cartilage with the sternum near

aortic; the upper border of the cartilage and *the aortic* is just under cover of the sternum opposite the lower part of the same cartilage.

sounds heard best; The sound produced at the pulmonary orifice is heard best in the second left intercostal space, and that produced at the aortic orifice in the second right intercostal space.

auriculo-ventricular openings: left; The auriculo-ventricular openings are nearer the circumference of the heart, and each is posterior to the artery issuing from the fore part of its ventricle. The left auriculo-ventricular opening is nearest of all to the back of the heart, and is marked on the surface by a line extending inwards and a little downwards to the middle of the sternum from the upper part of the fourth left costal cartilage at its junction with the sternum.

right. The right auriculo-ventricular opening is situated behind the right half of the sternum opposite the fourth intercostal space in a line passing downwards and a little to the right.

Dissection. The large vessels between the base of the heart and the upper opening of the thorax will now be made ready for examination and the parts upon which they lie carefully cleaned.

Vessels joining the heart. GREAT VESSELS. The arteries which take origin from the heart are the aorta and the pulmonary trunk. The large veins entering the heart, besides the coronary sinus, are the superior and inferior cavæ, and the pulmonary.

The pulmonary artery The PULMONARY ARTERY (fig. 163, p. 448, and fig. 164, p. 452), is a short thick trunk, which conveys the dark blood from the right side of the heart to the lungs. From its commencement in the right ventricle the vessel is directed upwards and backwards on the

divides into two for the lungs. left of the aorta; and at a distance of an inch and a half or two inches, it divides into two branches for the lungs. The trunk of the pulmonary artery is contained in the pericardium; and beneath its lower end is the beginning of the aorta. On each side are the coronary artery and the auricular appendix.

Right branch. The *right branch* is longer and somewhat larger than the left. In its course to the lung it passes outwards above the right auricle of the heart, and behind the aorta and superior vena cava.

Behind it is the right bronchus. At the lung the artery divides into three primary branches, one for each lobe.

Left branch.

The *left branch* is directed in front of the descending aorta and the left bronchus to the fissure of the lung, where it ends in two branches for the two lobes.

Space at the bifurcation.

As the right and left branches of the pulmonary artery pass outwards, they cross the two bronchi diverging from the end of the trachea, and enclose with them a lozenge-shaped space which contains some bronchial glands (fig. 163).

Ligament of arterial duct.

Ductus arteriosus (fig. 164). Near the bifurcation of the pulmonary artery a fibrous cord, about the size of a crow-quill, passes from the left branch of the vessel to the arch of the aorta. This is the remnant of the ductus arteriosus of the fœtus, and is named the *ligament of the arterial duct.*

Arterial duct in fœtus: course of the blood.

In the fœtus the right and left branches of the pulmonary artery are small, and the trunk is continued by the ductus arteriosus, which opens into the aorta beyond the origin of the last great branch (left subclavian) of the arch. The impure blood from the superior venæ cavæ passes into the right ventricle and thence proceeds by the pulmonary artery, whereby most of it reaches the aorta through the arterial duct, below the attachment of the vessels of the head and neck, in order that it may be transmitted to the placenta to be purified. After birth, when the function of the lungs is established, the great current of blood is directed along the branches of the pulmonary artery to the lungs, instead of through the arterial duct; and this tube, becoming gradually smaller, is occluded by the eighth or tenth day, and forms finally the ligament of the arterial duct.

The aorta extends through chest and abdomen.

The AORTA (fig. 170, p. 466; and fig. 171, p. 467) is the great systemic vessel which conveys the arterial blood from the heart to the different parts of the body. It first ascends for a short distance, and then arches backwards to reach the spinal column, along which it is continued downwards through the chest and abdomen. In the thorax the vessel is divided into *three parts*—the ascending aorta, the arch of the aorta, and the descending thoracic aorta.

Ascending aorta: length, extent, and relations.

The ASCENDING AORTA springs from the left ventricle of the heart behind the left half of the sternum, on a level with the lower border of the third costal cartilage. About two inches, or a little more, in length, it is directed upwards, with a slight inclination to the right and forwards, and reaches to the inner end of the cartilage of the second rib on the right side. It is contained nearly altogether in the pericardium, being surrounded by the same sheath of the serous membrane as the pulmonary trunk, which is at first superficial to it, but afterwards lies on its left side. Between the ascending aorta and the sternum are the anterior edge of the right lung, with the pleura, and some fatty tissue. Behind it are the left auricle of the heart and the right branch of the pulmonary artery. On the right side is the descending cava. Near the heart the vessel bulges opposite the flaps of the valve (sinuses of Valsalva; fig. 170). There is

sometimes another dilatation along the right side, which is named the *great sinus of the aorta.*

Branches. From the lower end of the ascending aorta arise the two coronary arteries of the heart (fig. 170, *o*), which have already been noticed (p. 455).

Arch of aorta

The ARCH OF THE AORTA extends from the second right costal cartilage to the lower border of the body of the fourth dorsal vertebra, on the left side. The convexity of the arch is upwards, and from it the three large arteries for the supply of the upper part of the body arise. The vessel recedes from the sternum, being at first inclined to the left across the front of the trachea, and then directed backwards to the left side of the fourth dorsal vertebra, where it turns downwards to join the descending aorta. It thus forms a second curve with the convexity to the left side.

forms two curves:

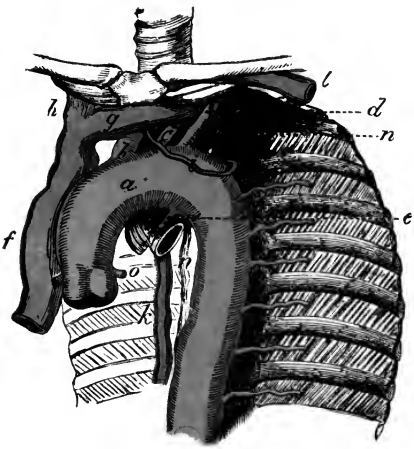


FIG. 170.—ARCH OF THE AORTA AND ITS GREAT BRANCHES.

a. Aortic arch.
b. Innominate artery.
c. Left common carotid.
d. Left subclavian.
e. Ligament of arterial duct.
f. Vena cava superior.
g. Left innominate vein.
h. Right innominate vein.
i. Left upper intercostal vein.
k. Large azygos vein.
l. Left subclavian vein.
n. Thoracic duct.
o. Coronary artery.

relations.

The arch rests upon the trachea, the œsophagus, the thoracic duct, and the fourth dorsal vertebra. In front of it are the remains of the thymus gland, and some fat. On the left side are the left pleura and lung, and the left phrenic, superficial cardiac, and vagus nerves, the last sending inwards its recurrent branch beneath the vessel. Along the upper border, in front of the great branches, is the left innominate vein (fig. 171), to which the left upper intercostal vein is directed over the hinder part of the arch; and to the lower border, near its termination, the remnant of the arterial duct is attached.

Objects contained in the arch.

Below the concavity of the arch of the aorta are the root of the left lung, the branching of the pulmonary artery with its arterial duct, and the left recurrent laryngeal nerve.

Three branches of the arch.

The three large BRANCHES of the arch supply the neck, the head, and the upper limbs. First on the right is the trunk of the innominate artery; close to it is the left common carotid; and last of all comes the left subclavian.

The INNOMINATE ARTERY (brachio-cephalic), the first and largest of the three branches, measures from one inch and a half to two Innominate artery ends in carotid

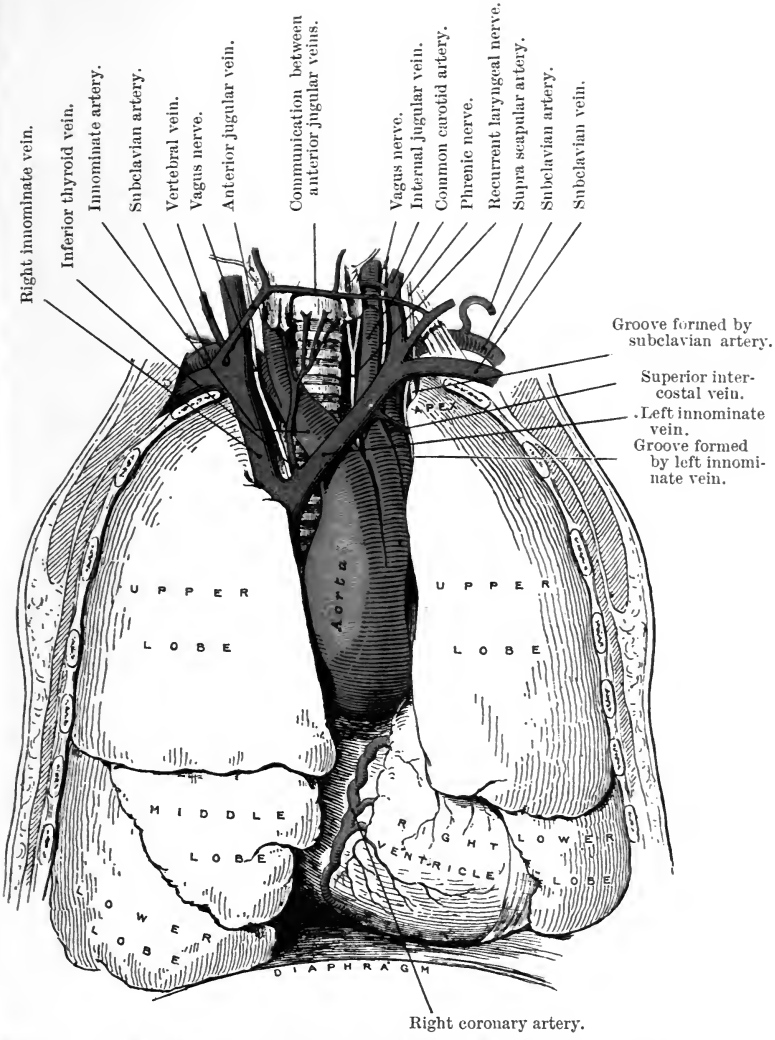


FIG. 171.—THE CONTENTS OF THE THORAX SEEN FROM THE FRONT. THE LUNGS WERE FILLED WITH MELTED WAX AND WERE HELD APART IN FRONT UNTIL THE WAX HAD SET. (FROM A SPECIMEN IN CHARING CROSS HOSPITAL MUSEUM.)

inches in length. Ascending to the right beneath the sternum, it divides opposite the sterno-clavicular articulation into the right common carotid and subclavian arteries. and subclavian:

relations

The artery is crossed by the left innominate vein, and lies behind the upper piece of the sternum, and the origins of the sterno-hyoid and sterno-thyroid muscles. At first it rests on the trachea, but as it ascends it is placed on the right side of the air-tube. To its right is the innominate vein of the same side. Usually no lateral branch arises from this artery.

Left common carotid:

LEFT COMMON CAROTID ARTERY. The common carotid artery of the left side of the neck is longer than the right by the distance between the arch and the top of the sternum.

relations in the thorax.

In the thorax the artery ascends obliquely to the left sterno-clavicular articulation, but not so close as the innominate to the first piece of the sternum and the origin of the depressor muscles of the hyoid bone and larynx. In this course it passes beneath the left innominate vein, and the remains of the thymus gland. At first it lies on the trachea, but afterwards inclines to the left of that tube, so as to be placed over the œsophagus and the thoracic duct. To its outer side is the left vagus, with one or more cardiac branches of the sympathetic nerve.

Left subclavian artery:

The LEFT SUBCLAVIAN ARTERY ascends to the neck through the upper aperture of the thorax, and then curves outwards between the scaleni, where it has the same relations as the vessel of the right side.

course and relations in the chest.

The trunk is directed almost vertically from the arch of the aorta to the level of the first rib. In the thorax it is deeply placed, near the spine. To its inner side is at first the trachea, and afterwards the œsophagus with the thoracic duct. On its outer side it is invested by the left pleura, and in the hardened specimen its position is represented by a shallow groove in the lung, in which it rests. The left innominate vein crosses in front of the vessel as it enters the neck. Somewhat anterior to the artery, though running in the same direction, are some of the cardiac nerves.

The great veins are:—

VEINS. In addition to the cardiac veins, there are the superior and inferior cavæ, and the pulmonary veins;—the former are the great systemic vessels which return impure blood to the right auricle of the heart; and the latter convey pure blood from the lungs to the left auricle.

Vena cava superior:

The SUPERIOR or DESCENDING VENA CAVA (fig. 170, *f*, and fig. 171) results from the union of the right and left innominate veins, and brings to the heart the blood of the head and neck, upper limbs, and thorax.

formed by innominate veins;

Its origin is placed behind the junction of the first costal cartilage of the right side with the sternum. From that spot the large vein

course;

descends to the pericardium, perforates the fibrous layer of that bag about one inch and a half above the heart, and ends in the right auricle. On its outer surface the vein is covered by the pleura, and

relations;

the phrenic nerve is in contact with it. To the inner side are the innominate artery and the ascending aorta. Behind the vein is the root of the right lung.

branches.

When the cava is about to perforate the pericardium it is joined posteriorly by the large azygos vein; and higher up it receives small veins from the pericardium, and the parts in the mediastinum.

The INNOMINATE VEINS are two in number, right and left; and each is formed near the inner end of the clavicle by the junction of the subclavian and internal jugular veins. Below, they are united in the superior cava. The trunks differ in length and direction, and in their relations to surrounding parts (fig. 171). Innominate veins:

The *right vein* is about one inch long, and descends almost vertically, on the right side of the innominate artery, to its junction with the opposite vein. On the outer surface the pleura covers it, and along it the phrenic nerve is placed. right,

The *left vein* is nearly three inches in length, and is directed obliquely to the right, along the upper border of the arch of the aorta. It crosses behind the sternum, and the remains of the thymus gland; and it lies on the three large branches of the aortic arch, as well as on the nerves descending over the arch. and left;

The *tributaries* of the veins are nearly alike on the two sides. Each receives the vertebral and the internal mammary of its own side, and occasionally the inferior thyroid, though these veins more often blend into one trunk below, which opens into the junction of the two innominate veins or into the left. The left vein also is joined in addition by the superior intercostal, and some small thymic and pericardial veins. their tributaries.

Occasionally the innominate veins are not united in the vena cava, but descend separately to the heart, where each has a distinct opening in the right auricle. When such a condition exists, the right vein takes the course of the upper cava in front of the root of the right lung; but the left vein descends in front of the root of the left lung, and turning to the back of the heart, receives the cardiac veins, before it opens into the right auricle. A cross branch generally connects the two above the arch of the aorta. Sometimes they open separately into the heart.

This occasional condition in the adult is a regular one at a very early period of the growth of the fœtus; and the two vessels are also persistent in some mammalia.

Change of the two veins into one. The changes taking place in the veins during fœtal growth, to produce the usual arrangement in the adult, concern the trunk on the left side. The following is an outline of them. First a cross branch is formed between the two trunks, and this enlarging gives rise to the left innominate vein. Then the left trunk below the cross branch disappears at its middle, and undergoes transformation at each end:—At the upper end it becomes converted into a part of the superior intercostal vein. At the lower end it remains pervious for a short distance as the coronary sinus; and the small oblique vein opening into the end of that sinus in the adult is a remnant of the trunk as it lay beneath the heart. How two are changed into one, and coronary sinus formed.

In the adult there is a trace of the occluded vessel in the form of a small fibrous band in the vestigial fold of the pericardium (p. 451).

The INFERIOR OR ASCENDING VENA CAVA enters the right auricle as soon as it has pierced the diaphragm. No branches join the vein in the thorax. Vena cava inferior.

The PULMONARY VEINS are two on each side, upper and lower. They issue from the hilum of the lung, and end in the left auricle: their position in regard to the other vessels of the root has been noticed at p. 449. Four pulmonary veins.

The right veins are longer than the left, and lie beneath the right auricle of the heart. The superior receives its roots from Right veins the longer.

the upper and middle lobes of the lung; and the inferior vein is formed by branches from the lower lobe.

Left veins. The left veins cross in front of the descending aorta; and one springs from each lobe of the lung.

NERVES OF THE THORAX.

Nerves of the thorax. The pneumo-gastric and the sympathetic nerves supply the viscera of the thorax; and the phrenic nerve courses through the cavity to the diaphragm.

To trace vagus. **Dissection.** The phrenic nerves have already been fully displayed; but the pneumo-gastric nerves are now to be prepared.

The vagus is to be followed, on each side, behind the root of the lung, and its large plexus in that position is to be dissected out, the lung being thrown well over to the opposite side: some fine branches from the gangliated cord of the sympathetic coming forwards over the spinal column to the plexus, must also be looked for. The vagus also supplies a few filaments to the front of the root. Beyond the root, the nerve is to be pursued along the œsophagus by raising the lung and removing the pleura.

Phrenic nerve from the cervical plexus, passes to diaphragm. The PHRENIC NERVE is derived from the anterior division of the cervical plexus; from the fourth and fifth cervical nerves, mainly from the fourth. In its course through the thorax it lies along the side of the pericardium, and at a little distance in front of the root of the lung, with a small companion artery. When near the diaphragm it divides into branches, which perforate the muscle, and are distributed on the under service. The nerves of opposite sides differ in length, and in their relations above the root of the lung.

Right nerve above root of lung. The *right nerve* is shorter and straighter than the left. On entering the chest it crosses behind the subclavian vein, but in front of the internal mammary artery; and it lies afterwards along the right side of the innominate vein and superior cava till it reaches the pericardium.

Left nerve above root. The *left nerve* crosses the subclavian artery, and has the same position as the right to the mammary vessels when entering the cavity. In the thorax it is directed over the arch of the aorta to the root of the lung, and makes a curve lower down around the projecting heart. Before reaching the aorta the nerve is placed external to the left common carotid artery; and it inclines gradually from without inwards, so as to be in front of the left vagus over the aortic arch.

Some offsets. *Branches.* Some small filaments are said to be furnished from the nerve to the pleura and pericardium.

Internal mammary artery INTERNAL MAMMARY ARTERY. A small part of this artery, which lies beneath the first rib, and winds round the phrenic nerve and the innominate vein to reach the side of the sternum, is now to be seen. It gives the following offset:—

gives phrenic branch. The *superior phrenic branch* (comes nervi phrenici) is a very slender artery, which accompanies the phrenic nerve to the diaphragm, and is distributed to that muscle, anastomising therein

with the phrenic artery from the aorta, and with the musculo-phrenic branch of the internal mammary.

Vagus nerve.

The PNEUMO-GASTRIC or VAGUS NERVE passes through the thorax to the abdomen. In the lower part of the thorax the right and left nerves have a similar position, for they pass behind the root of the lung, each on its own side, and along the œsophagus to the stomach. But above the root of the lung, the two nerves have different relations. Each supplies branches to the viscera, viz., to the heart, the windpipe and lungs, and the gullet.

Right vagus above root of lung

The *right vagus* enters the thorax between the subclavian artery and the innominate vein, and is directed obliquely backwards, by the side of the trachea, to the posterior aspect of the root of the lung, where it gives rise to the posterior pulmonary plexus. From the plexus two large offsets are continued to the back of the gullet, and unite below into one trunk, which reaches the posterior surface of the stomach.

and on back of œsophagus.

Left nerve above root of lung

The *left* nerve appears in the thorax on the outer side of the left common carotid artery, and courses over the arch of the aorta, and beneath the root of the lung, forming there a larger plexus than on the right side. From the pulmonary plexus one or two branches pass to the front of the œsophagus, and join with offsets of the right nerve in a plexus; but the pieces are collected finally into one trunk, which is continued on the front of the gullet to the anterior part of the stomach.

and on front of œsophagus.

Branches are:—

The *branches* of the pneumo-gastric nerve seen in the thorax are the following:—

Recurrent laryngeal.

a. The *recurrent* or *inferior laryngeal nerve*, arising on the right side below the subclavian artery, and on the left at the lower border of the arch of the aorta immediately external to the ductus arteriosus, bends inwards to the trachea, along which it ascends to the larynx. On each side this branch is freely connected with the cervical cardiac branches of the sympathetic nerve, especially on the left side beneath the arch of the aorta.

Cardiac branches:

b. Cardiac branches (*thoracic*). Besides the cardiac branches furnished by the vagus in the neck, other offsets pass in front of the trachea to the cardiac plexus. On the right side they come from the trunk of the vagus and the recurrent branch, but they are supplied by the recurrent nerve alone on the left side.

lower cervical cardiac branch.

The termination of the *lower cervical cardiac branch* of each vagus nerve may now be seen. The branch of the right nerve lies by the side of the innominate artery, and joins a cardiac offset of the sympathetic of the same side; and the branch of the left vagus crosses over the arch of the aorta, to end in the superficial cardiac plexus (p. 457).

Pulmonary branches:

c. Pulmonary branches. There are two sets of nerves for the lung, one on the anterior and the other on the posterior aspect of the root.

small anterior;

The *anterior branches*, two or three in number, are small, and communicate with filaments of the sympathetic on the pulmonary artery: these nerves are best seen on the left side.

large posterior form a plexus.

The *posterior branches* are larger and much more numerous. Forming a plexiform arrangement (*posterior pulmonary plexus*) behind the root of the lung by the flattening and splitting of the trunk of the nerve, they are joined by filaments from the third and fourth ganglia of the knotted cord of the sympathetic, and are conveyed into the lung on the divisions of the airtube.

Œsophageal branches form a plexus.

d. Œsophageal branches are furnished to the gullet, but in greatest abundance in the lower half. Below the root of the lung the branches of the pneumo-gastric nerves surround the œsophagus with a network (*plexus gulæ*).

Sympathetic in thorax consists of

SYMPATHETIC NERVE. In the thorax the sympathetic nerve consists of a knotted cord along each side of the spinal column, which communicates with the spinal nerves; and of a large prevertebral or cardiac plexus, which distributes branches to the heart and the lungs.

a gangliated cord,

The gangliated cord will be seen in a future stage of the dissection, after the heart and the lungs have been removed.

and a central cardiac plexus.

The CARDIAC PLEXUS lies over the lower end of the trachea, and above the bifurcation of the pulmonary artery. A part of this network, the superficial cardiac plexus, has been already described on page 457. The remaining part, or the deep cardiac plexus, is placed beneath the arch of the aorta.

Dissection of the plexus:

Directions. The cardiac plexus has been injured by the previous examination of the heart, so that it should be dissected in a body in which the heart and the large vessels are entire, but the student should make them out in his part as well as he can.

to expose the right part,

Dissection. The ascending aorta is to be cut across near the heart, and is to be drawn over to the left side, after the manner of fig. 163, p. 448: next, the upper cava is to be divided above the entrance of the azygos vein, and its lower part is to be thrown down. By the removal of some fibrous and fatty tissues and lymphatic glands, the right part of the plexus will be seen in front of the trachea, above the right branch of the pulmonary artery. The offsets to the heart should be followed downwards on the trunk of the pulmonary artery; and those to the lung should be traced along the right branch of that vessel.

and the left.

To lay bare the part of the plexus into which the nerves of the left side enter, the aorta is to be cut through a second time, between the subclavian artery and the attachment of the ligament of the ductus arteriosus; and the arch is to be turned upwards with the great vessels attached. The lymphatic glands and the areolar and fatty tissue being cleared away from the plexus as on the opposite side, the offsets to the left coronary plexus of the heart will be visible.

Deep cardiac plexus.

The *deep cardiac plexus* is situate between the trachea and the arch of the aorta, and consists of right and left halves, which are joined by cross branches. In it are united the cardiac nerves of the sympathetic and vagus, with the exception of two branches of the left side; and from it nerves are furnished to the heart and lungs.

Right part, how formed;

The *right part of the plexus* is placed above the right branch of the pulmonary artery, and receives the nerves of the right side,

viz., the cardiac nerves of the sympathetic in the neck, the cardiac branches of the trunk of the vagus in both the neck and chest, and the cardiac offsets of the recurrent branch.

The branches of this half of the plexus are distributed mostly to the right side of the heart, and pass downwards before and behind the right branch of the pulmonary artery; those in front run on the trunk of the pulmonary artery to end in the right coronary plexus (p. 457); and the nerves behind supply the right auricle of the heart. Offsets are sent laterally on the branch of the artery to the root of the lung. branches to right coronary plexus; a few go to root of lung.

The *left half of the plexus* lies close to the ligament of the arterial duct, and rather on the left of the trachea. In it are collected the cardiac nerves of the sympathetic ganglia of the left side of the neck, except the highest, and numerous and large branches of the left recurrent nerve of the vagus. Left part: nerves entering it;

Nerves descend from it to the heart around the left branch and the trunk of the pulmonary artery, and after supplying branches to the left auricle, terminate in the left coronary plexus (p. 457). A considerable offset is directed forwards by the side of the ligament to the superficial cardiac plexus; and some nerves reach the left anterior pulmonary plexus by coursing along the branch of the pulmonary artery. offsets end in left coronary plexus, and in root of lung.

Termination of the three *cardiac branches of the sympathetic nerve* of the neck (upper, middle, and lower). Other cardiac nerves.

On the right side there may be only two cardiac nerves entering the thorax, for the highest nerve is often blended with one of the others. These nerves pass beneath the subclavian artery to the right half of the deep plexus; and they communicate with the branches of the recurrent laryngeal nerve of the vagus. The right enter deep plexus.

On the left side the highest cardiac nerve lies over the arch of the aorta, and ends in the superficial cardiac plexus; it may give a branch beneath the arch to the deep plexus. Only one other nerve, the middle cardiac, is usually seen entering the left side of the deep plexus, as the lower one generally blends with it. One left enters superficial; all others the deep plexus.

OPENING OF THE AORTA AND STRUCTURE OF THE HEART.

Dissection. The aorta having been cut across, the student will examine its interior as it springs from the heart.

The *opening of the aorta* is anterior to that of the auricle, and close to the septum. This aperture is round, and rather smaller than that of the pulmonary artery, measuring slightly less than an inch in diameter. Aortic opening: size and position;

In its interior is a *valve* of three semilunar or sigmoid flaps, which are thicker and stronger than the corresponding parts in the pulmonary artery, but have a like structure and attachment (p. 461). The projection in the centre of each valve, the *corpus Arantii*, is better marked. Opposite each valve the coat of the aorta is bulged as in the pulmonary artery, though in a greater degree, and forms valve.

Sinuses of Valsalva.

a hollow on the inner side, named *sinus of Valsalva*. The cusps of the valve are an *anterior* and a *right* and *left posterior* in relative position, and the right coronary artery arises in the anterior sinus of Valsalva, and the left in the left posterior sinus.

Use.

Like the valves in the pulmonary artery, these meet in the middle to prevent the blood passing back into the ventricle, and combine with them in causing the second sound of the heart.

Structure of the heart.

STRUCTURE. The heart is composed chiefly of muscular fibres, together with certain fibrous rings and a fibro-cartilage.

Dissection. The auricles should now be snipped round at their junction with the ventricles, and the pulmonary artery and aorta similarly cut round close to the attachments of the cusps of the valves. The ventricular portion of the heart can then be cut away and a view of the four valvular orifices obtained, and sections should be made through them to demonstrate the fibrous rings around the orifices.

Fibrous bands

The *fibrous structure* forms rings around the auriculo-ventricular and arterial orifices, and is prolonged into the valves connected with these openings.

form rings around auriculo-ventricular

The *auriculo-ventricular rings* give attachment to the framework of fibrous tissue in the tricuspid and mitral valves; and the band surrounding the left auriculo-ventricular opening is blended in front with the aortic ring.

and arterial openings.

The *arterial rings* surround the aortic and pulmonary orifices; and the margin of each towards the artery forms three notches with intervening projections. The notches are occupied by thinner parts of the arterial wall bounding the sinuses of Valsalva; and to the concave edges the sigmoid flaps of the valve are attached.

Fibro-cartilage.

Behind the aortic opening, between it and the auriculo-ventricular apertures, is a piece of *fibro-cartilage*, with which the fibrous rings are united.

Dissection. The inter-ventricular septum should now be cut through from below upwards.

The inter-ventricular septum.

The *interventricular septum* appears as a stout pyramidal muscular mass, between the two ventricles, but it will be seen that the muscular tissue ceases close to the aortic orifice, and that, for a short distance at the upper part, the ventricles are only separated by a fibrous septum (*pars membramacea septi*). Sometimes a communication between the two ventricles occurs at this place, occasioning one of the forms of congenital malformation of the heart.

Special preparations needed.

The STRUCTURE OF THE HEART beyond the stage already described cannot be followed in the ordinary dissecting-room preparation, and the further details can only be followed in a heart that has been specially prepared. For this purpose a fresh heart is obtained (commonly of a sheep or an ox), which, having been washed out, is filled with a mixture of flour and water, and boiled for a quarter of an hour, so as to destroy the connective tissue, and to allow the stretched and hardened muscular fasciculi to be separated from one another.

Until such a specimen is obtained, the student may omit the following description.

The *muscular fibres* of the heart, although involuntary, are striped; but they differ in their character from those of the voluntary muscles. The fibres of the auricles are distinct from those of the ventricles. Muscular substance of heart.

In the *wall of the auricles* the fibres are mostly transverse (fig. 172. *a*, *b*), and are best marked near the ventricles, though they form there but a thin layer; and some of the fibres dip into the septum between the auricular cavities. Besides this set, there are annular fibres surrounding the appendages of the auricles and the endings of the different veins; and lastly, a few looped fibres (*c*, *d*) pass obliquely over the auricle from front to back. Fibres of the auricles are transverse, annular, and looped.

Dissection. The auricles having been learnt, separate them from the ventricles by dividing the fibrous auriculo-ventricular rings. Next clean the fleshy fibres of the ventricles by removing all the fat from the base of the heart around the two arteries (aorta and pulmonary), and from the anterior and posterior surfaces. Detach auricles.

Before cutting into the heart, let the student note that the anterior surface is to be recognised by the fibres turning in at the septum, with the exception of a small band at the base and another at the apex; while on the posterior aspect the fibres are continued from the left to the right ventricle across the septum.

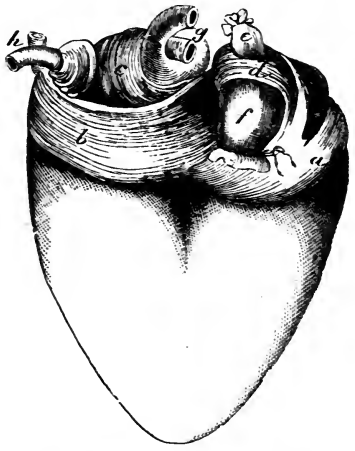


FIG. 172.—MUSCULAR FIBRES OF THE AURICLES.

a. Transverse fibres of the right, and *b*, of the left auricle.

c. Looped fibres of the left, and *d*, of the right auricle.

e. Superior cava.

f. Inferior cava.

g. Right, and *h*, left pulmonary veins. Annular fibres surround the veins.

To show the direction of the muscular bundles in the left ventricle, divide the superficial fibres in front longitudinally near the septum, and transversely about half an inch below the left auriculo-ventricular opening; and reflect a thin layer of the fibres carefully towards the left side. In the same way a second layer is to be reflected; then a third, and so on, each layer that is raised being about as thick as the thin end of the scalpel. It will not be difficult to demonstrate thus six or seven layers in the wall; and as each is raised, the fleshy fibres will be seen to change their direction (fig. 173). Dissection of left ventricle,

On the right side a similar dissection may be made, and a like number of layers may be displayed, but greater care will be necessary owing to the thinness of the wall. Make a vertical cut along the anterior aspect from the root of the pulmonary artery to the apex of the ventricle; and reflect the several layers inwards and outwards. As the superficial ones are raised, their fibres may be followed into the septum in front, and across the middle line into the wall of the left ventricle at the back. and of right.

Thickness of the ventricular walls. The wall of the left ventricle is in general nearly three times as thick as that of the right. Its thickest part is about one-fourth of its length from the base; and at the apex it is very thin. The free wall of the right ventricle is of more uniform thickness than the left. The septum is about as thick as the wall of the left ventricle, except at the Thickness of left ventricle, of right, and of septum:

membranous part of septum.

upper end, in a small area close below the aortic orifice, where there is a very thin part from which muscular fibres are absent (*pars membranacea septi*.

Fibres can be separated into layers by dissection.

Arrangement of fibres. It has been shown by the foregoing dissection that the direction of the muscular fasciculi composing the ventricular wall varies at different depths from the surface, and that at a given spot a number of layers may be separated, which are characterised by the difference in direction of their fibres. Such a division into distinct layers is, however, in great measure artificial, for the change in direction is gradual, and many fibres pass across from one layer to another, and have to be cut to effect the separation.

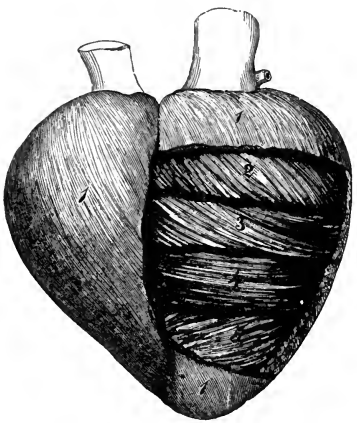
Direction of fibres:

Over both ventricles the most superficial fibres are directed very obliquely from base to apex, and from right to left on the anterior surface, from left to right on the posterior surface. Proceeding inwards, the obliquity gradually diminishes; and in the centre of the wall the fibres are transverse. Within the last, as the cavity of the ventricle is approached, the fibres become oblique again, but in the opposite direction to the external ones; and the innermost fibres of all are nearly longitudinal.

external,

middle,

and internal.



Course of fibres is obscure.

The attempt to trace the whole course of the bundles is, except in the case of the superficial fibres, attended with great difficulty, owing to the interlacement, branching, and joining of the fasciculi. The principal groups of fibres that have been distinguished may be arranged as follows; but it must be understood that they are to a great extent intermixed, and that bundles frequently pass from one set into another.

Chief sets:

FIG. 173.—A DIAGRAM OF THE ARRANGEMENT OF THE FIBRES IN LAYERS IN THE LEFT VENTRICLE. THE DISSECTION IS CARRIED THROUGH ABOUT TWO-THIRDS OF THE THICKNESS OF THE WALL.

1, 2, 3. Outer layers, the fibres of which gradually become less oblique.

4. Middle layer of transverse fibres.

5. Inner set of oblique fibres. The deepest fibres, corresponding to 1 and 2 of the exterior, are not shown.

external oblique

a. The external oblique fibres (fig. 173) begin at the base of the ventricles, where most of them spring from the auriculo-ventricular and arterial fibrous rings, and descend with the spiral course above described to the apex of the heart. On the posterior surface they pass without interruption from the left to the right ventricle; but in front the fibres crossing the right ventricle in part dip in at the interventricular groove to the septum, while those continued to the left ventricle are joined by others which issue from the septum along the furrow. At the apex of the heart they form a sharp twist, known as the *vortex* or *whorl*, and sink in it to become deep and ascend towards the base as the innermost layer of the left ventricle. Some of them are continued to the base and join the auriculo-ventricular and aortic rings; but others enter the papillary muscles, which are thus formed.

and internal longitudinal are one;

annular;

b. The transverse or annular fibres (fig. 173) are partly special to the left ventricle, and partly common to the two ventricles. Some of them appear to form simple rings round the cavities, but a great many pass from this into the oblique system of fibres.

looped of left,

c. The looped fibres of the left ventricle spring from the fibrous rings

at the base, and passing downwards in the ventricular wall, enter the lower part of the septum, in which they ascend to the central fibro-cartilage.

d. Similar looped fibres pass from the outer wall of the right ventricle through the septum to the fibro-cartilage. and of right ventricle;

e. The figure-of-8 fibres pass from the front of the right ventricle through the septum to the back of the left, and from the front of the left to the back of the right, the two sets decussating in the septum. figure-of-8 fibres.

Endocardium. Lining the interior of the cavities of the heart is a thin membrane, which is named endocardium. It is continuous on the one hand with the lining of the veins, and on the other with that of the arteries. Where the membrane passes from an auricle to a ventricle, or from a ventricle to an artery, it forms duplicatures in which fibrous tissue is enclosed, thus giving rise to the valves; and in the ventricles it covers the tendinous cords, and the projecting muscular bundles. The thickness of the membrane is greater in the auricles than in the ventricles, and in the left than in the right half of the heart. Lining membrane of the heart.

THE TRACHEA AND LUNGS.

Dissection. To see fully the pieces of the air-tube in the root of the lung, it will be necessary to divide the branches of the pulmonary artery and the pulmonary veins. And when the upper part of the arch of the aorta is turned to one side, the dissector will be able to clear away the bronchial glands, the nerves, and the connective tissue from the part of the trachea in the thorax, and from the branches into which it bifurcates.

The TRACHEA, or windpipe, reaches from the larynx to the lungs, and lies on the front of the spinal column. The tube begins opposite the sixth cervical vertebra; and it ends commonly at the lower border of the fourth dorsal vertebra by dividing into two pieces (bronchi), one for each lung. Trachea ends in bronchi.

In the thorax (fig. 163, p. 448) the trachea is situate with the great vessels in the superior mediastinum; and its lower end is usually inclined somewhat to the right side. Here it is covered by the left innominate vein, by the arch of the aorta, with the origins of the innominate and left common carotid arteries, and by the cardiac plexus of nerves. Behind the airtube is the œsophagus, which projects to the left above the arch of the aorta. On the right side are the pleura, the vagus, and the innominate artery for a short distance, after this has passed over the trachea; and on the left side lie the left subclavian artery, and the recurrent branch of the vagus. Its relations in the thorax.

The BRONCHI, or the branches of the airtube, are contained in the roots of the lungs, and are surrounded by vessels, glands and nerves. Near the lung each is divided into as many primary pieces as there are lobes. In their structure and form the bronchi resemble the windpipe, for they are round and cartilaginous in front, but flat, and muscular and membranous behind. Their position behind the other pulmonary vessels has been described at p. 449. Bronchi lie in the roots of the lungs; are like the trachea in form.

The *right bronchus* is about an inch in length, and is larger than the left; it also forms a more direct continuation of the trachea, from which circumstance a foreign body in the airtube is more likely to enter this bronchus. It passes obliquely outwards, on a The right differs from the

level with the fifth dorsal vertebra, behind the upper cava and the right pulmonary artery ; and the azygos vein arches above it.

left in size and relations. The *left bronchus* is about two inches long, and reaches to the level of the sixth dorsal vertebra. It is directed obliquely downwards below the arch of the aorta, and crosses behind the corresponding pulmonary artery. It lies in front of the œsophagus and descending thoracic aorta.

Remove the lungs. **Dissection.** The lungs are now to be removed from the body by cutting through the bronchi and the small vessels of the root.

Take away heart and pericardium. The remains of the heart and pericardium are then to be taken away ; the inferior cava is to be divided, and the pericardium is to be detached from the surface of the diaphragm : in removing the pericardium, the dissector should be careful not to injure the structures contained in the interpleural space in front of the spine.

Surface of lung is smooth; is marked by lobules and small cells. PHYSICAL CHARACTERS OF THE LUNG. The surface of the lung is smooth and shining, and is invested by the pleura. Through the serous covering the mass of the lung may be seen to be divided into small irregularly shaped pieces or lobules. On looking closely at it, when a piece of pulmonary pleura is pulled away from its substance, minute cells will be perceived in it.

Colour varies with age. The tint of the lung varies with age. In infancy the colour is a pale red ; but in the adult the texture becomes greyish, and presents here and there dark grey spots or lines of pigment, the shade of which deepens with increasing age, and becomes even black in old

Accidental colour. people. After death, the colour of the posterior border may be bluish-black from the accumulation of blood.

Consistence. To the touch the lung is soft and yielding, and on a section the pulmonary substance appears like a sponge ; but the lung which is deprived of air by pressure has a tough leathery feel. Slight

Crepitation, pressure with the thumb and finger drives the air from the containing spaces through the pulmonary structure, and produces the noise known as crepitation. If the lung contains serum or mucus, a frothy red fluid will run out when it is cut.

and elasticity. The texture of the lung is very elastic, this elasticity causing the organ to contract when the thorax is opened, and to expel air that may be blown into it.

Specific gravity, The specific gravity of the lung varies with the conditions of dilatation and collapse, or of infiltration with fluid. When the pulmonary substance is free from fluid, and filled with air, it floats in water ; but when it is quite deprived of air it is slightly heavier

and weight of the lung. than water, and therefore sinks. The weight of the lung is influenced greatly by the quantity of foreign material contained in its texture ; ordinarily it ranges from sixteen to twenty-four ounces, the right lung being about two ounces heavier than the left. In the male the lungs are larger, and, together, they are about twelve ounces heavier than in the female.

Lung consists of lobules, and these of air-cells. OBVIOUS STRUCTURE OF THE LUNG. The substance of the lung is composed of small polyhedral masses or lobules, which are hollow, and again subdivided into minute vesicles called the air-cells. The lobules are visible as little polygonal areas, marked by the lines of

pigment, upon the surface of the lung; and by inflating a portion of the organ, the cellular structure may be seen. The several lobules are united together by connective tissue without fat; and each is attached to a terminal branch of the airtube, and receives offsets of the pulmonary vessels.

Serous covering and sub-serous layer.

The lung is invested by the pulmonary pleura, except at the hilum, where the vessels enter. The serous membrane is thin and transparent, and is closely attached to the lung-substance by means of a fine layer of subserous areolar tissue, which is continuous with the interlobular tissue. Both the pleura and the subserous tissue are very elastic, so that in the collapsed state the surface of the lung is still smooth.

Relation of artery to bronchus, on left side, and on right.

Arrangement of the airtube and pulmonary artery entering the lung. It has already been seen that in the root of the lung the pulmonary artery lies at first in front of the bronchus; but before entering the organ the artery crosses over, and gains the posterior surface of the airtube. On the left side the artery passes backwards above the undivided bronchus; but on the right side the bronchus gives off the branch (*epiarterial bronchus*) to the upper lobe of the lung before it is crossed by the arterial trunk, which therefore runs between the upper and middle divisions of the airtube. From this arrangement it would appear that the lower half of the left bronchus and the two lobes of the left lung are represented on the right side by the continuation of the bronchus below the artery and by the middle and lower lobes of the lung; and that the upper lobe of the right lung with its division of the airtube have no representatives on the left side.

Airtubes in lung: mode of branching; structure; and ending.

Bronchial branches in the lung. If the primary divisions of the bronchi be followed into the lung, they will be found to give off secondary branches; and these, together with the smaller offsets of the air-passages, divide for the most part dichotomously, that is evenly into two. The branches of the airtube within the lung are known as the *bronchia* or *bronchial tubes*, and differ from the bronchi in being circular in section. Their structure resembles that of the bronchi; but the pieces of cartilage are irregular in shape and occur on all sides of the tube, and the muscular tissue is proportionately greater in amount and completely surrounds the canal. The ultimate bronchial tubes are about half a line in diameter; and each leads to a group of somewhat funnel-shaped dilatations (*infundibula*), which are beset with air-cells and form the lobules of the lung.

Vessels are two sets:—

Vessels of the lung. Two sets of vessels are furnished to the lung, viz., the pulmonary, which bring blood to the lung to be aerated, and then return it to the heart and the smaller bronchial, which convey the blood destined for the nutrition of the lung.

Pulmonary artery,

The *pulmonary artery* divides like the bronchus, and within the lung its branches run usually on the posterior surface of the bronchial tubes, which they accompany to the lobules. The arterial branches do not anastomose together; and they end in the capillary network of the air-cells.

and veins. The *pulmonary veins* are not so regular in their arrangement as the arteries. They arise from the network of the air-cells; and the branches from adjoining lobules communicate freely together. The larger branches for the most part lie in front of the airtubes which they accompany. The pulmonary veins have no valves.

Bronchial arteries, The *bronchial arteries* are derived directly or indirectly from the aorta, two for the left lung and one for the right (p. 481), and enter the lung on the airtube, which they also follow in its ramifications. They distribute branches to the bronchial lymphatic glands, to the walls of the larger blood-vessels and bronchial tubes, and to the interlobular connective tissue. Other small offsets ramify on the surface of the lung beneath the pleura. On the smallest bronchial tubes minute branches anastomose with offsets of the pulmonary arteries.

and veins. The *bronchial veins* begin by twigs corresponding with the superficial and deep branches of the artery, and leave the root of the lung to end in the azygos veins. Many of these veins, however, open into the pulmonary veins, both within the lung and in the root.

Lymphatics. The *lymphatics* of the lung are superficial and deep; the latter accompany both the bronchia and the branches of the pulmonary vessels. All pass to the bronchial glands at the root of the lung.

Pulmonary nerves. The *nerves* of the lung are derived through the pulmonary plexuses from the vagus and sympathetic, and follow the branches of the airtube. They have minute ganglia connected with their filaments.

PARTS OF THE SPINE AND THE SYMPATHETIC CORD.

In front of the spinal column are the objects in the interpleural space of the posterior mediastinum, viz., the aorta, azygos veins, thoracic duct, and œsophagus; and beneath the pleura on each side of the spine is the sympathetic nerve.

Dissection of thoracic duct, **Dissection** (fig. 174). The *thoracic duct* should be found first near the diaphragm by removing the pleura; there it is about as large as a crow-quill, and rests against the right side of the aorta.

of other objects, The areolar tissue and the pleura are to be cleared away from the different structures before mentioned; and the azygos veins, one on the right and two on the left of the aorta, should be dissected. Next follow the thoracic duct upwards beneath the arch of the aorta, and along the œsophagus beneath the pleura, till it leaves the upper aperture of the thorax.

and of sympathetic. After raising the pleura from the inner surface of the vertebræ and ribs, the *gangliated cord of the sympathetic* nerve will be seen lying over the heads of the ribs. Branches are to be followed outwards from the ganglia to the intercostal nerves; and others inwards over the bodies of the vertebræ,—the lowest and largest of these forming the three trunks of *the splanchnic nerves.*

Descending thoracic aorta; The DESCENDING THORACIC AORTA is the part of the great systemic vessel between the termination of the arch and the diaphragm. Its

extent is from the lower border of the fourth dorsal vertebra, on the left side to the front of the last dorsal vertebra. extent;

Contained in the posterior mediastinum, the vessel is rather curved, lying at its upper end on the left, and below on the front of the spinal column. Beneath it are the vertebræ and the smaller azygos veins. In front of the vessel are the root of the left lung and the pericardium. On its left side it is covered throughout by course; and relations.

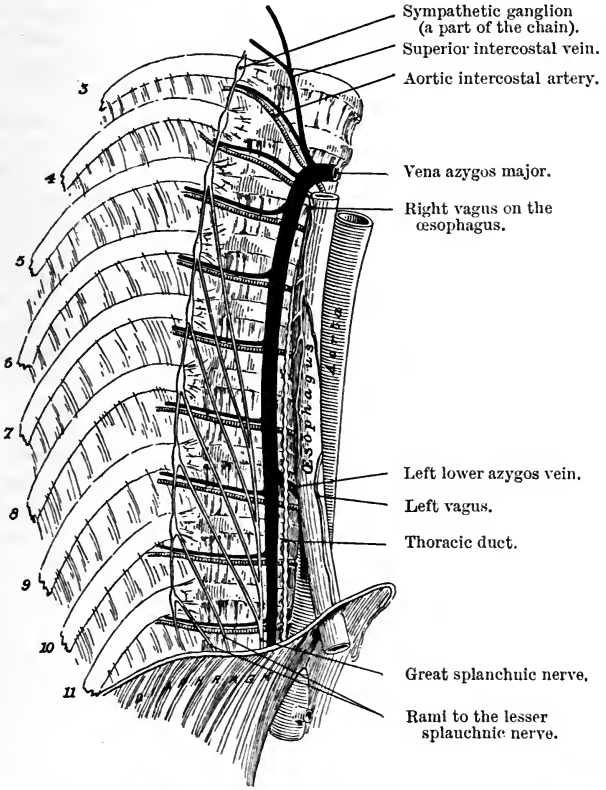


Fig. 174.—Diagram of Structures in the Posterior Mediastinum.

the pleura; and on its right side are the œsophagus, the thoracic duct, and the large azygos vein, though near the diaphragm the gullet is placed over the aorta (fig. 174).

The BRANCHES of the vessels are distributed to the surrounding parts, and are named from their destination bronchial, pericardial, œsophageal, mediastinal, and intercostal. Branches.

a. The *bronchial arteries* supply the structure of the lungs, and adhere to the posterior part of the bronchial tubes, on which they ramify; they give some twigs to the bronchial glands and the œsophagus. Arteries of the lung: distribution.

two left ; There are two arteries for the *left lung* (superior and inferior), which arise from the front of the aorta at a short distance from each other.

one right. The artery of the *right lung* arises in common with one of the left bronchial arteries (superior), or from the first intercostal artery of the right side.

Pericardial branches. *b.* The *pericardial branches* are some irregular twigs, which are furnished to the posterior part of the pericardial bag.

Œsophageal branches. *c.* The *œsophageal branches* are four or five in number, and ramify in the gullet, forming anastomoses with one another ; above, they communicate with branches of the inferior thyroid artery ; and below, with twigs of the coronary artery of the stomach.

Mediastinal branches. *d.* Small *mediastinal branches* (posterior) supply the areolar tissue and the glands in the interpleural space.

Intercostal arteries : *e.* The INTERCOSTAL ARTERIES are nine on each side, and pass to the same number of lower intercostal spaces. Branches are supplied

number ; to the upper two spaces from the intercostal artery of the subclavian trunk.

course to intercostal spaces ; These vessels arise from the posterior part of the aorta, and run outwards on the bodies of the vertebræ, beneath the cord of the sympathetic nerve, to the intercostal spaces, where each divides into *an anterior and a posterior branch.* In this course the upper arteries have a somewhat oblique direction ; and as the aorta lies on the

right longer. left of the spine, the right vessels are the longer, and run also beneath the œsophagus, the thoracic duct, and the large azygos vein. Many twigs are supplied to the bodies of the vertebræ.

The anterior branch In the intercostal space, the *anterior branch*, the larger of the two, continues onwards between the muscular strata to the front of the chest, where it ends by anastomosing with an intercostal branch of

occupies intercostal space the internal mammary artery (p. 441). At first the artery lies in the middle of the space, beneath the pleura, and resting on the external intercostal muscle ; but near the angle of the rib it ascends to the upper boundary. Accompanying the artery

with vein and nerve. are the intercostal vein and nerve,—the vein being commonly above, and the nerve below it ; but in the upper spaces the nerve is, at first, higher than the artery.

Offsets. *Branches* are furnished to the intercostal muscles, and to the ribs. Near the angle of the rib a larger (*collateral*) branch is given off, which runs forwards along the lower border of the space, and joins in front a branch of the internal mammary ; and about the middle (from front to back) of the intercostal space a superficial twig arises, to accompany the lateral cutaneous nerve.

Anastomoses. The highest artery of the aortic set of intercostals anastomoses with the superior intercostal branch of the subclavian artery. The lowest two are continued in front into the abdominal wall, where they lie between the internal oblique and transversalis muscles, and anastomose with the epigastric and lumbar arteries.

Posterior branch turns to the back. The *posterior branch* turns backwards between the vertebra and the superior costo-transverse ligament, and is distributed in the back. As it passes the intervertebral foramen it furnishes a small

spinal branch to the vertebra and the spinal cord. See VESSELS OF THE SPINAL CANAL (p. 549).

The *intercostal vein* closely resembles the artery in its course and branching. Near the head of the rib it receives a contributing dorsal branch, and then joins an azygos vein. Intercostal vein.

Bronchial veins. A vein issues from the root of each lung, and ends on the right side in the large azygos vein, and on the left in the superior azygos vein of its own side. Vein of the lung.

The SUPERIOR INTERCOSTAL ARTERY of the subclavian trunk descends over the neck of the first rib, external to the cord of the sympathetic, and supplies a branch to the first intercostal space: continuing to the second space, which it supplies in like manner, it ends by anastomosing with the upper aortic intercostal. Superior intercostal supplies two spaces

Its intercostal offsets divide into anterior and posterior branches, which are distributed like the intercostal branches of the aorta.

The AZYGOS VEINS are two in number on the left side and one on the right, and receive branches corresponding to the offsets furnished by the descending thoracic aorta. Three azygos veins.

The *right* or *large azygos* (fig. 174, p. 481, and fig. 175, [3], p. 486) begins in the *right ascending lumbar vein* on the right side of the spine in the abdomen. It enters the thorax through the aortic opening of the diaphragm, and ascends on the right side of the aorta and thoracic duct, over the intercostal arteries and the bodies of the vertebræ. Opposite the fifth rib the vein arches forwards above the root of the right lung, and enters the superior cava as this vessel pierces the pericardium. Its valves are few and very incomplete, and the intraspinal and intercostal veins may be injected through it. Large azygos is on right side, and joins superior cava:

Branches. In this vein are received :— branches joining it.

1. Eight lower intercostal veins of the right side.
2. Right superior intercostal vein bringing blood from the second and third spaces.
3. Left lower azygos vein, bringing blood from the lower three or four spaces of the left side.
4. Left upper azygos vein bringing blood from the fourth, fifth, sixth, and seventh spaces of the left side.
5. Right bronchial vein.
6. Small œsophageal, mediastinal, and vertebral veins.

By means of the right azygos vein the inferior vena cava communicates with the superior, so that blood can reach the heart from the lower half of the body if the inferior cava were obstructed.

The *left lower azygos vein* (fig. 175, [4]) begins in the abdomen in the *ascending lumbar vein* of the left side of the vertebral column. Entering the thorax along the aorta, or through the crus of the diaphragm, the vein ascends on the left of the aorta as high as the ninth or eighth dorsal vertebra, where it crosses beneath that vessel and the thoracic duct to end in the right azygos. It receives the three or four lower intercostal veins of the left side, and some œsophageal and mediastinal branches. Left lower azygos begins in abdomen, ends in larger azygos: branches.

The *left upper azygos vein* (fig. 175, [5]) is formed by offsets from Left upper vein.

Superior intercostal vein :

the spaces between the superior intercostal above, and the left lower azygos below. It usually receives branches from the fourth to seventh spaces inclusive, and the trunk either joins the lower azygos of its own side, or crosses the spine to open into the right vein.

ending of right,

The *superior intercostal vein* is a short trunk which is formed by the union of the veins from the second, third, and, occasionally, from the fourth spaces. On the right side it descends to join the beginning of the arch of the large azygos vein ; but on the left

and of left.

side (fig. 170, *i*, p. 466) it is directed forwards across the arch of the aorta, and then turns upwards to enter the left innominate vein.

Vein from first space.

The *highest intercostal vein* ascends from the first intercostal space, in company with the superior intercostal artery, and joins the lower end of the vertebral vein.

Œsophagus

The ŒSOPHAGUS or gullet (figs. 174 and 175) is a hollow muscular tube, which extends from the pharynx to the stomach, and the thoracic part is now to be examined.

in the thorax,

Appearing in the thorax to the left of the middle line, it is directed beneath the arch of the aorta, and reaches the middle of

passes through diaphragm.

the spine about the fifth dorsal vertebra. From that spot it is continued through the interpleural space on the right of the aorta, till near the diaphragm, where it takes a position over the aorta, to gain the œsophageal opening.

Parts covering it,

As far as the aortic arch the œsophagus lies beneath the trachea, though it projects to the left of the airtube ; beyond the arch it is crossed by the left bronchus, and is thence in contact with the

beneath it,

pericardium as far as the diaphragm. At the upper part of the thorax it rests on the longi colli muscles and the vertebræ; but below the arch of the aorta it is separated from the spine by the large azygos vein, the thoracic duct, and the right intercostal arteries, as well as by the aorta near the diaphragm. Laterally it touches

and on sides.

the left pleura above the arch, and both pleuræ below, but the right much more extensively than the left. Below the bronchus the pneumo-gastric nerves surround the œsophagus with their branches ; and above the same spot the thoracic duct is in contact with it on the left.

Three coats are in it.

Structure. If a piece of the œsophagus be removed and distended with tow, it will be easy to show a muscular, an areolar, and a mucous coat from without inwards.

A muscular coat of

The *muscular coat* is thick and strong, and consists of two layers of fibres, of which the external is longitudinal, and the internal circular in direction, like the muscular tunic of the other parts of the alimentary tube. In the upper third of the œsophagus the muscular coat is red, and composed of striped fibres ; but below this it becomes gradually paler, and the striped fibres give way to involuntary muscular tissue.

external longitudinal

The *external layer* is formed of parallel longitudinal fibres, which form a continuous covering, and end below on the stomach. The fibres begin in the neck opposite to the cricoid cartilage ; and at intervals varying from half an inch to an inch and a half, they are

interrupted by small tendons ($\frac{1}{20}$ to $\frac{1}{10}$ of an inch long) like the fibres of the rectus abdominis muscle.

The *internal layer* of circular fibres is continuous above with the fibres of the pharynx; they are more oblique at the middle than at either end of the œsophagus. and internal circular fibres.

The *areolar* or *submucous layer* is situate between the muscular and mucous coats, and attaches the one to the other loosely. Fibrous layer.

The *mucous coat* will be seen on cutting open the tube: it is reddish in colour above but pale below, and is very loosely connected with the muscular coat, so that it is thrown into longitudinal folds when the œsophagus is contracted. The surface is studded with minute papillæ, which are, however, concealed by the thick, laminated, scaly epithelium. Mucous coat. Papillæ and epithelium.

Some *compound glands* (œsophageal) are scattered along the tube, and are most numerous at the lower end of the gullet. Some glands.

LYMPHATICS OF THE THORAX. In the thorax are lymphatic vessels of the wall and the viscera, which enter collections of glands, and end in one or other of the lymphatic ducts. Besides these, the large thoracic duct traverses the thorax in its course from the abdomen to the neck. Lymphatics in the thorax.

LYMPHATIC GLANDS. Along the course of the internal mammary artery lies a chain of *sternal glands*, which receive lymphatics from the upper part of the abdominal wall, the front of the chest, the mamma, and the fore part of the diaphragm. Sternal glands.

On each side of the spine, near the heads of the ribs, as well as between the intercostal muscles, is placed a group of *intercostal glands* for the reception of the lymphatics of the posterior wall of the thorax. Intercostal.

Three or four *anterior mediastinal glands* lie in the fore part of the interpleural space, and receive lymphatics from the upper surface of the liver and the diaphragm. Anterior mediastinal.

Numerous *bronchial glands* are situate at the division of the trachea, and along the bronchi; through them the lymphatics of the lung pass. Bronchial.

Along the side of the aorta and œsophagus is a chain of *posterior mediastinal glands*, which are joined by the lymphatics of the œsophagus, and hinder parts of the pericardium and diaphragm. Posterior mediastinal.

Along the front and lower border of the arch of the aorta are the *superior mediastinal* or *cardiac glands*, which receive the lymphatics of the heart, the pericardium, and the thymus. Superior mediastinal.

The THORACIC DUCT (fig. 174 and fig. 175, [1]) is the main channel by which the lymph of the lower half of the body, and of the left side of the upper half of the body, as well as the chyle from the intestines, is conveyed into the blood. The duct begins in the abdomen in an enlargement (receptaculum chyli; p. 371), and ends in the veins of the left side of the neck. It is from fifteen to eighteen inches in length, and is contained in the thorax, except at its origin and termination. It has the following course and relations:— Thoracic duct. begins in the abdomen and ends in neck.

Entering the cavity through the same opening as the aorta, the duct ascends on the right side of that vessel as high as the arch. Relations in the thorax.

Opposite the fourth dorsal vertebra it passes beneath the aortic arch, and is then applied to the left side of the œsophagus, on which it is conducted to the neck under the left subclavian artery. At the lower part of the neck it arches outwards, external to the common carotid artery and above or over the subclavian artery, to open into the left subclavian vein at its junction with the internal jugular.

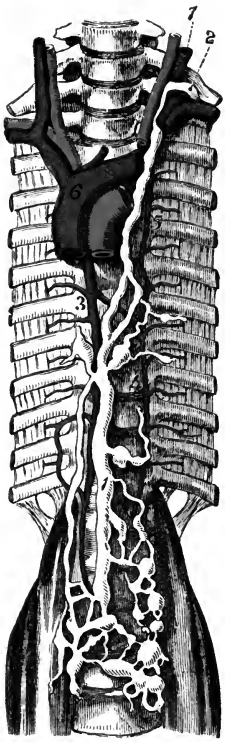


Fig. 175.—The Thoracic Duct, and the Azygos Veins.

1. Thoracic duct.
2. Ending of the duct in the left subclavian vein.
3. Large azygos vein.
4. Left lower azygos vein.
5. Left upper azygos vein.
6. Vena cava superior.
7. Left internal jugular vein, cut through.

It may be divided; is furnished with valves; receives most lymphatics.

In this course the tube is oftentimes divided in two, which unite again; or its divisions may even form a plexus. Near its termination it is frequently branched.

It is provided with valves at intervals, like a vein: and these are in greatest number at the upper part.

Branches. In the thorax the duct receives the lymphatics of the left half of the cavity, viz., from the sternal and intercostal glands; also the lymphatics of the left lung, the left side of the heart, and the trachea and œsophagus.

Right duct is in the neck: receives lymphatics of one-fourth of body.

The RIGHT LYMPHATIC DUCT receives large branches from the viscera of the thorax, and is a short trunk in the neck, about half an inch in length, which opens into the angle of union of the subclavian and jugular veins of the same side: its opening is guarded by valves.

Branches. Into this trunk the lymphatics of the right upper limb and right side of the head and neck pour their contents. In addition, the lymphatics of the right side of the chest, right lung and right half of the heart, and some from the right lobe of the liver, after passing through their respective glands, unite into a few large trunks, which ascend beneath the innominate vein to reach the duct in the neck.

Thoracic cord of sympathetic has twelve ganglia.

CORD OF THE SYMPATHETIC NERVE (fig. 174, p. 481). The thoracic part of the gangliated cord of the sympathetic nerve is covered by the pleura, and is placed over the heads of the ribs and the intercostal vessels. The ganglia on it are usually twelve, one being opposite each dorsal nerve, but this number is frequently reduced by the fusion of two adjoining ones. The first ganglion is the largest; and the last two are rather anterior to the line of the others, being situate on the side of the bodies of the corresponding vertebræ.

Each ganglion furnishes external branches to communicate with the spinal nerves, and internal for the supply of the viscera.

Branches:

External or *connecting branches* (fig. 176). Two offsets pass outwards from each ganglion to join a spinal nerve (intercostal). In the branches of communication both spinal and sympathetic nerve-fibres are combined; but one (*white ramus communicans*) (*h*) consists almost entirely of spinal, and the other (*grey ramus communicans*) (*i*) mainly of sympathetic fibres.

to join spinal nerves;

The *internal* or *visceral branches* differ in size and distribution, according as they are derived from the upper or lower ganglia.

to supply viscera.

The offsets of the *upper five ganglia* are very small, and are distributed to the aorta, and to the vertebræ with the ligaments. From the third and fourth ganglia also, offsets are sent to the posterior pulmonary plexus.

Offsets of upper five ganglia are small;

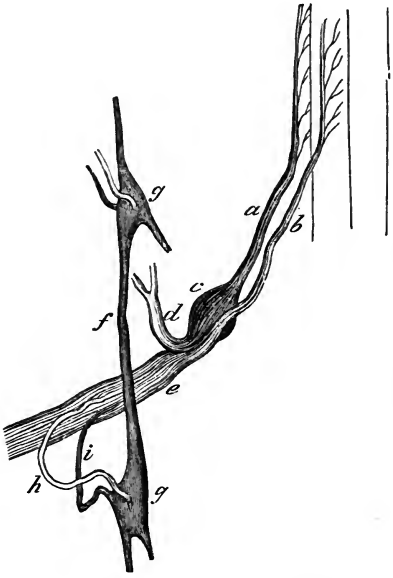


Fig. 176.—Scheme to Illustrate the connection between the Spinal and Sympathetic Nerves (Todd and Bowman).

a. Posterior root of a spinal nerve, with a ganglion, *c*.
b. Anterior root.
d. Posterior primary branch.
e. Anterior primary branch of the spinal nerve.
f. Knotted cord of the sympathetic.
g. Ganglia on the cord.
h. White offset from the spinal to the sympathetic nerve.
i. Grey offset from the sympathetic to the spinal nerve.

The branches of the *lower seven ganglia* are larger and much whiter than the others, and are united to form visceral or splanchnic nerves of the abdomen: these are three in number (large, small, and smallest) and pierce the diaphragm to end in the solar and renal plexuses.

of lower seven, large, and form

The *great splanchnic nerve* is a large white cord, which receives roots apparently from only four or five ganglia (sixth to the tenth), but its fibres may be traced upwards on the knotted cord as high as the third ganglion. Descending on the bodies of the vertebræ, it pierces the fibres of the crus of the diaphragm, and ends in the semilunar ganglion of the abdomen. At the lower part of the thorax the nerve may present a ganglion.

great splanchnic

to semilunar ganglion;

The *small splanchnic nerve* begins in the tenth and eleventh ganglia, or in the intervening cord. It is transmitted inferiorly

small splanchnic to cœliac plexus;

through the crus of the diaphragm, and enters the part of the solar plexus by the side of the cœliac artery.

smallest splanchnic to renal plexus.

The *smallest splanchnic nerve* springs from the last ganglion, and accompanies the other nerves through the diaphragm; in the abdomen it ends in the renal plexus. This nerve may be absent, and its place is then taken by an offset of the preceding.

PARIETES OF THE THORAX.

Soft parts bounding the thorax.

Between the ribs are lodged the two layers of intercostal muscles, with the intervening nerves and arteries; and inside the ribs is a thin fleshy layer at the back,—the subcostal muscles. The base of the thorax is formed by the diaphragm.

Subcosta s; position;

The SUBCOSTAL MUSCLES are small slips of fleshy fibres, which are situate on the inner surface of the ribs, where the internal intercostals cease. Apparently part of the inner intercostals, they arise

attachments;

from the inner surface of one rib, and are attached to the like surface of the rib next succeeding.

irregularities;

They are uncertain in number, but there may be ten: they are smaller above than below, and the upper and lower may pass over more than one space.

and use.

Action. The subcostals draw together, and depress the ribs, thus acting as expiratory muscles.

Intercostal muscles.

INTERCOSTAL MUSCLES. The anterior part of these muscles has been described (p. 438); and the posterior part may now be examined from the inner side.

Inner layer reaches angle of the rib;

The *inner muscle* begins at the sternum, and reaches back to the angles of the ribs, or somewhat farther in the upper spaces. Where the fibres cease, a thin fascia (*posterior intercostal aponeurosis*) is continued inwards over the outer muscle. The inner surface is

relations.

lined by the pleura, and the opposite surface is in contact with the intercostal nerve and vessels.

Outer layer

External muscle. When the fascia and the subcostal muscles have been removed, the external intercostal will be seen between the posterior border of the internal muscle and the spine. Its

extends back to tuberosity of the rib.

fibres cross those of the inner intercostal layer. While this muscle extends backwards to the tuberosity of the rib, it is generally absent, as already described, in front, between the rib-cartilages.

Trace nerves.

Dissection. In a few spaces the internal intercostal muscle may be cut through, and the intercostal nerve and artery traced outwards.

Eleven intercostal nerves.

The INTERCOSTAL NERVES, eleven in number, are anterior primary branches of dorsal nerves; and they pass from the intervertebral foramina into the intercostal spaces without forming a plexus. Near the head of the rib each nerve is joined to the sympathetic

Upper and lower ones differ.

by the two communicating filaments just mentioned. The upper six are confined to the wall of the thorax; but the lower five are prolonged into the abdominal wall, where the ribs cease in front.

Last dorsal nerve.

The anterior branch of the twelfth dorsal nerve lies below the last rib, and is seen in the dissection of the abdomen.

Upper six nerves. At first the nerves lie between the pleura and the external intercostal muscle with an artery and vein; but they soon enter between the intercostal muscles, and extend forwards to the side of the sternum (p. 439). In their course they supply *branches* to the muscles of the thoracic wall, as well as to the levatores costarum and serrati muscles of the back, and cutaneous offsets to the surface, which are described in the dissection of the upper limb (p. 13). Course of upper six, and branches.

There are some deviations in the first and second nerves from the arrangement above specified. Exceptions in first two.

The *first nerve* ascends in front of the neck of the first rib, and enters the brachial plexus. Before it leaves the chest it supplies to the first intercostal space a branch, which furnishes muscular offsets, and becomes cutaneous by the side of the sternum. There is not any lateral cutaneous offset from this branch, except when the second nerve is not as large as usual. First nerve ends mostly in brachial plexus.

The *second nerve* may extend a considerable way on the wall of the chest before entering between the intercostal muscles; and it frequently sends upwards a branch to join the first nerve. It is remarkable in having a very large lateral cutaneous branch, which we have seen described in the upper limb as the intercosto-humeral nerve. In front it ends like the others. Second nerve.

The *lower five nerves* resemble the foregoing in their course and branches in the intercostal spaces: their termination in the abdominal wall is described on p. 274. Lower five nerves.

Upper surface of the diaphragm. The centre of the muscle is tendinous, and the circumference is fleshy. In contact with the upper surface are the lung with the pleura on each side, and the heart and pericardium in the middle: the phrenic vessels and nerves pierce this surface, external to the pericardium. In the diaphragm are the following apertures;—one for the œsophagus and the pneumo-gastric nerves, a second for the vena cava, a third for the aorta with the thoracic duct and the large azygos vein, and a cleft on each side for the splanchnic nerves. Beneath it the sympathetic passes into the abdomen. Upper surface of diaphragm. Parts touching. Apertures in it.

Section III.

LIGAMENTS OF THE TRUNK.

The ligaments of the vertebræ, ribs, and sternum are now to be examined. Articulations of the ribs,

Articulations of the ribs. Each rib is united to the spinal column at the one end, and to the costal cartilage at the other. Between it and the spine there are two synovial joints, and two sets of ligaments, viz., one between the head of the rib and the bodies of the vertebræ, and a second passing from the neck and tuberosity to the transverse processes of the vertebræ.

and costal cartilages.

The costal cartilages are connected to the sternum and to one another by synovial joints and ligaments.

To see the costo-vertebral ligaments,

Dissection. For the purpose of examining the ligaments between the ribs and the vertebræ, take the piece of the spinal column with the third, fourth, fifth, and sixth ribs attached to it. After removing the intercostal and other muscles, and the loose tissue from the surface of the bones, the student will be able to define, as below, the ligaments passing from the head and neck of the rib to the bodies and transverse processes of the vertebræ.

and chondro-sternal.

The ligaments attaching the costal cartilages to the sternum are to be dissected on the part of the thorax which was removed in opening the cavity.

Ligaments of head of rib are

LIGAMENTS OF THE HEAD OF THE RIB. Where the head of the rib is received into a hollow in the bodies of two contiguous vertebræ, there are two ligaments to the articulation — anterior costo-central, and interarticular, with two synovial sacs.

anterior or stellate

The *anterior costo-central or stellate ligament* (fig. 177, 3) is composed of radiating fibres, which pass from the head of the rib to the two vertebral bodies forming the articular cavity, and to the disc between them. Where the rib is in contact only with one vertebra, *i.e.*, in the first, eleventh and twelfth, a few fibres ascend to the vertebra immediately above.

FIG. 177.—LIGAMENTS OF THE RIBS AND VERTEBRÆ (BOURGERY).

1. Anterior ligament of the bodies of the vertebræ.
2. Short lateral fibres uniting the bodies.
3. Stellate ligament.
4. Superior costo-transverse ligament.
5. Interspinous ligament.

and interarticular,

The *interarticular ligament* will be seen when the stellate is divided. It is a very short thin band, which is attached on one side to the ridge separating the two articular surfaces on the head of the rib, and on the other to the intervertebral disc. In the joints of the first, eleventh, and twelfth ribs, where the head is not in contact with the intervertebral substance, it is absent.

with synovial sacs.

Synovial sacs. There are usually two synovial cavities in the costo-central articulation, one on each side of the interarticular ligament; but in the three joints before mentioned (1st, 11th, 12th) there is but one. The special features of these joints should be verified at this time.

Costo-transverse ligaments:

LIGAMENTS OF THE NECK AND TUBEROSITY. Three ligaments pass from the neck and tuberosity of the rib to the transverse processes of the two vertebræ with which the head is connected;

and the tuberosity forms a synovial joint with the transverse process of the lower vertebra.

The *superior costo-transverse ligament* (fig. 177, [4]) is larger and longer than the others. It ascends from the upper edge of the neck of the rib to the transverse process of the vertebra above: it is wanting to the first rib. Between this ligament and the vertebra the posterior branches of the intercostal vessels and nerves pass; and externally it is continued into the posterior intercostal aponeurosis. superior or ascending,

The *posterior costo-transverse ligament* (fig. 184, [3], p. 497) is a short band of fibres between the rough part of the tuberosity of the rib and the tip of the transverse process with which the latter articulates. posterior,

The *middle* or *interosseous costo-transverse ligament* is placed between the neck of the rib and the transverse process which the tuberosity touches. It will be best seen by sawing horizontally through the rib and the transverse process. Its fibres are collected into separate bundles, with fatty tissue between them. and middle;

The *synovial cavity* of the costo-transverse articulation will be opened by dividing the posterior ligament. synovial sac.

There is no joint between the last two ribs and their transverse processes; and the posterior and middle costo-transverse ligaments are united in one band. Differences in eleventh and twelfth ribs.

Movements of the ribs. The ribs undergo a movement of rotation around an axis which passes through the costo-central articulation in a direction corresponding very nearly to that of the neck of the bone. By this rotation the fore part of the rib is carried upwards and outwards in inspiration, and downwards and inwards in expiration. The degree of outward movement is necessarily proportionate to the obliquity of the axis, and is therefore greater in the case of the lower ribs than the upper, since the backward inclination of the transverse process of the dorsal vertebræ, and of the necks of the ribs, increases from above downwards. The lower ribs, while being elevated, also move somewhat backwards, their tuberosities gliding over the sloped facets of the transverse processes; and in the eleventh and twelfth ribs the upward and downward movements are but slight, while the forward and backward movements are relatively free, owing to the absence of the costo-transverse articulation. The ribs rotate around an axis, which is more or less oblique. The lower ones also move backwards and forwards.

COSTAL CARTILAGE WITH THE RIB. The end of the rib is hollowed to receive the costal cartilage, and the two are directly united. The periosteum of the rib is continued into the perichondrium of the cartilage. Rib and cartilage.

CHONDRO-STERNAL ARTICULATIONS will now be examined in the portion of sternum that had previously been put aside, and in what remains on the body. The cartilages of the true ribs, except the first, are articulated to the sternum by synovial joints. The extremity of each cartilage is received into a depression on the side of the sternum, and is fixed by a surrounding capsule. In front and behind the capsule is thickened by radiating fibres, which are described as *anterior* and *posterior ligaments*. Costal cartilages with the sternum.

In the joint of the second cartilage there is an *interarticular* Second cartilage has a double joint.

ligament like that to the head of the rib which joins the cartilage between the pieces of the sternum; and the synovial sac is double. Similar bands are sometimes present in one or two of the succeeding joints.

Costo-xiphoid ligament.

A special band of fibres passes from the cartilage of the seventh rib to the ensiform process, and is named *costo-xiphoid ligament.*

First cartilage.

The cartilage of the first rib adheres directly to the sternum, without forming any joint.

Cartilages with one another.

INTERCHONDRAL ARTICULATIONS. The cartilages of the ribs from the sixth to the ninth articulate together by means of broad processes on their adjacent edges, which are connected by synovial joints. Each joint is surrounded by a short capsule, and is supported in front by strong fibres of the anterior intercostal aponeurosis. The ends of the eighth, ninth, and tenth cartilages are united each to the cartilage above by bands of fibrous tissue.

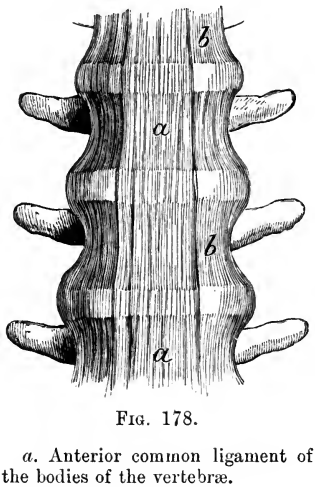


FIG. 178.

a. Anterior common ligament of the bodies of the vertebræ.
b. Lateral short fibres.

Motion of cartilages.

Movements. There is only a limited degree of movement in the chondro-sternal and interchondral articulations, the cartilages being elevated with the ribs in inspiration, and sinking in expiration.

Manubrium and body of sternum.

ARTICULATION OF THE STERNUM. The manubrium and body of the sternum are united by a piece of cartilage, with anterior and posterior longitudinal fibres. In some cases there is a cavity resulting from the absorption of the central portion of the cartilage. There is no appreciable movement between the pieces of the sternum, but the articulation aids in giving elasticity to the front of the chest.

Two sets of ligaments unite the vertebræ.

ARTICULATIONS OF THE VERTEBRÆ. The vertebræ are united together by two sets of ligaments,—one for the bodies, and the other for the arches and processes.

Along the spinal column the ligaments have a general resemblance, and one description will suffice, except for those between the first two vertebræ and the head and those of the pelvis, which are described in the head and neck and abdomen respectively.

How to see the several ligaments.

Dissection. After the articulations of the ribs have been examined, the same piece of the spinal column will serve for the preparation of the ligaments of the bodies of the vertebræ. The anterior ligament of the bodies will be defined with very little trouble, by removing the areolar tissue.

The spinal canal is assumed to have been opened in the examination of the spinal cord, and the posterior ligament of the bodies of

the vertebræ is laid bare; but if the canal should not be open, for any reason, the neural arches of the vertebræ are to be removed by sawing through the pedicles.

The remaining ligaments between the neural arches, spines, and articular processes of the bones may be dissected on the piece taken away in opening the spinal canal.

LIGAMENTS OF THE BODIES. The bodies of the vertebræ are united by an anterior and a posterior common ligament with an intervening piece of fibro-cartilage. The bodies are united by:—

The *anterior common ligament* (fig. 178, *a*) reaches from the axis to the sacrum. It is narrow above and wide below; and it also increases in thickness from above downwards. Its fibres are longitudinal; and by detaching parts of the ligament, the superficial ones will be seen to extend over three or four vertebræ, while Anterior common ligament: form and thickness; extent of fibres;

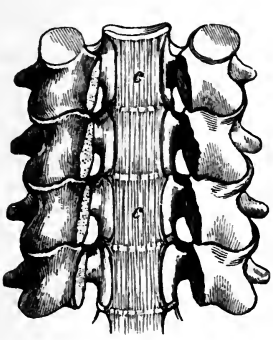


FIG. 179 A.

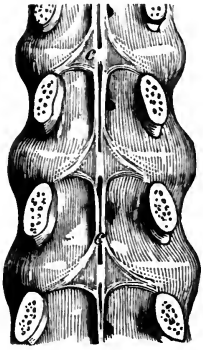


FIG. 179 B.

TWO VIEWS OF THE POSTERIOR COMMON LIGAMENT, *c*, TO SHOW THE DIFFERENCE IN SHAPE, A, IN THE NECK, AND B, IN THE LOINS.

the deepest pass from one bone to the next. More of the fibres are attached to the intervertebral discs than to the bones; and few or none are fixed to the centre of the bodies. The ligament bridges over the transverse hollows on the vertebral bodies, and renders the front of the column smooth and even. and mode of attachment.

On each side, over the part uncovered by the anterior common ligament, the bodies of the vertebræ are united by a thin layer of short fibres (fig. 178, *b*). Short lateral fibres.

The *posterior common ligament* (fig. 179) is contained in the spinal canal, lying on the back of the vertebral bodies from the axis to the sacrum. It is much thinner than the anterior, and, unlike that, is broad above and narrow below. It is wider opposite the intervertebral disc than on the bodies, so that the margins are dentate. In the neck (A) it covers nearly the whole breadth of the bodies; but in the dorsal and lumbar regions (B) it is a narrow band, which sends off a pointed process on each side to be attached to the intervertebral disc and the upper margin of the Posterior common ligament: form;

relations.

pedicle. The hinder surface of the ligament is in contact with the dura mater; and between the band and the centre of the bodies are intervals where large veins issue from the bones. The fibres are arranged as in the anterior ligament; and they are more closely united with the intervertebral substance than with the bone.

To see the intervertebral substance.

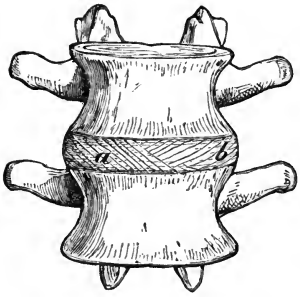


FIG. 180.—INTERVERTEBRAL SUBSTANCE IN THE LUMBAR REGION WITH ITS LAMINÆ DISPLAYED.

a. Superficial, and *b*, deeper layer, the fibres in the two taking different directions.

Dissection. To see the intervertebral discs, the anterior and posterior common ligaments must be taken away; and to show their structure, one disc should be cut through horizontally (fig. 182), while another is to be divided vertically by sawing through the bodies of two vertebræ (fig. 181).

Intervertebral discs: form and

The *intervertebral substances* or *discs* (fig. 180) are placed between the bodies of the vertebræ, with the exception of the atlas and axis. Each disc is a flattened or slightly biconvex plate (fig. 181), which is firmly united to the adjacent surfaces of two bodies; and its form and size are determined by the bones between which it lies. It is

connections;

connected in front and behind with the anterior and posterior common ligaments; and on the sides, in the dorsal region, with the stellate and interarticular ligaments of the ribs.

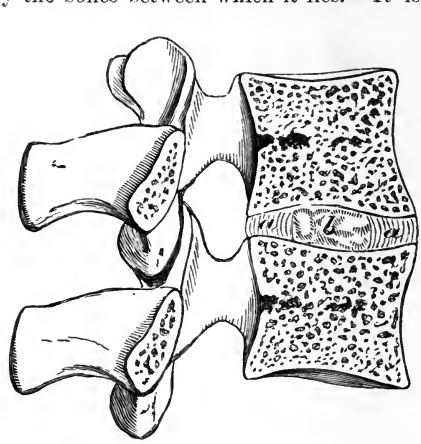


FIG. 181.—VERTICAL SECTION OF THE INTERVERTEBRAL SUBSTANCE.

a. Peripheral laminar part.
b. Central pulpy part.

structure;

In the sections that have been made the intervertebral substance is seen to consist of two different parts,—an external, firm and laminar, and an internal, soft and pulpy (fig. 181).

outer part of fibrous laminæ;

The outer laminar part (fig. 182, *a*) forms more than half of the disc. The laminæ are disposed concentrically, but do not form complete rings; and they are attached by their edges to the bodies of the vertebræ (fig. 181, *a*). They are composed for the most part of white fibro-cartilage; but the superficial ones consist of fibrous tissue. The fibres are parallel

in each lamina, and run obliquely between two vertebræ; but the direction is reversed in alternate layers (fig. 180). This arrangement is best seen in the thicker discs between the lumbar vertebræ; and it may be demonstrated by dissecting layer after layer.

inner part of pulpy substance,

The central pulpy portion of the disc (fig. 182, *b*) is very soft, and, being tightly confined by the surrounding laminæ, it projects when two vertebræ and the interposed mass are sawn through. Placed nearer the back than the front of the disc, it is more marked in the loins and neck than in the dorsal region. It has a yellowish colour, and is deficient in the stratiform arrangement so conspicuous in the circumferential part.

situation where largest.

Cartilage covering bones.

The surfaces of the vertebræ in contact with the disc have a cartilaginous covering, which may be seen by cutting the intervertebral substance from the bone. Over the centre of the osseous surface it forms a continuous layer, but it is wanting towards the circumference.

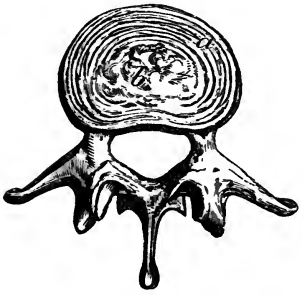


Fig. 182.—Horizontal Section of an Intervertebral Disc.

a. Laminar external part.
b. Pulpy central substance.

Thickness and form of discs.

The discs are thicker between the lumbar and cervical, than between the upper and middle dorsal vertebræ; and in the loins and neck, where the spinal column is convex forwards, they are deepest at the anterior edge, being wedge-shaped. The thickest piece of all, and the most wedge-shaped, is between the fifth lumbar vertebra and the sacrum. The total thickness of the discs amounts to about a fourth of the length of the moveable part of the spinal column.

They bind bones firmly together,

Use. The intervertebral discs form the chief bond of union between the several bones of the column; and mainly by reason of their strength, displacement of the vertebræ is a rare occurrence.

but permit movement;

In the movements of the spine the vertebræ revolve around the central pulpy portion of the disc; and the extent of the movement between two segments of the column is limited by the circumferential laminar portion of the discs.

render column convex.

Through their wedge-shaped form the discs are chiefly instrumental in giving rise to the convexity of the spine in the loins and neck; and by their elasticity they moderate the effect of jars or shocks transmitted through the column.

Several ligaments of the arch and processes.

Ligaments of the neural arches and processes. The articular processes of the vertebræ are connected by synovial joints with surrounding capsules; the neural arches are united by yellow ligaments; the spinous processes have one band along their tips and others in the intervals between them; and some of the transverse processes are joined by fibrous bands.

Articular have capsule and synovial sac.

Joints of articular processes. Between the articulating processes there is a moveable joint, in which the bones are covered with cartilage, and are surrounded by a *capsular ligament*, enclosing a *synovial membrane.* The capsules are loosest in the cervical, and strongest in the lumbar region.

Motion in the joints.

Movement. In these gliding joints the articular processes of the vertebræ move to a limited extent over one another, the direction of the motion being determined by the form and inclination of their surfaces. The kinds of movement permitted in any portion of the column are thus dependent upon the characters of the joints between the articular processes. The movements are freest in the cervical region, and least extensive between the upper dorsal vertebræ. By their overlapping, the articular processes also help in giving security to the spine; and in dislocation of the vertebræ they are generally broken off.

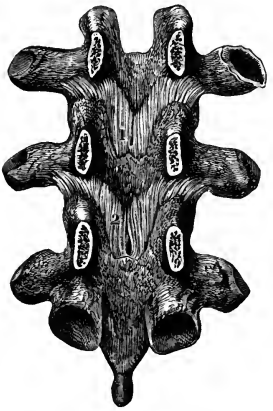


Fig. 183.—An Inner View of the Neural Arches of the Vertebræ, with their Interposed Ligaments (Bourgery).

1 and 2. Ligamenta subflava.

Yellow ligaments of the laminæ:

Ligaments of the arches. The *ligamenta subflava* (fig. 183) are small rhomboidal sheets of yellow elastic tissue, which close the intervals between the neural arches at the back of the spinal canal from the axis to the sacrum. In each interval there are two ligaments, a right and a left, which meet in the middle line, and extend from the root of the spine to the articular processes. They are attached above to the anterior or deep surface of the laminæ of one vertebra, and below to the upper border and posterior surface of the laminæ of the next. They are thin in the neck, and strongest in the loins.

extent; attachments; thickness.

Ligaments of spines:

Ligaments of the spines. Along the tips of the spinous processes of the dorsal and lumbar vertebræ is a longitudinal band of fibres (fig. 184, [1])—the *supraspinous ligament.* It is thickest in the lumbar region and consists of superficial fibres which pass over three or more spines, and deep fibres which unite adjoining bones. Many of the back muscles arise from it on each side.

supraspinous:

and interspinous.

In the same regions, there are also membranous *interspinous ligaments* (fig. 177, [5]) reaching from the root to the tip of the spinous processes. They are thicker and broader in the lumbar than in the dorsal part of the column.

In the neck the place of the supraspinous and interspinous ligaments is taken by the ligamentum nuchæ (p. 6).

Intertransverse ligaments.

Ligaments of the transverse processes. In the loins the *intertransverse ligaments* are thin membranous bands in the intervals between the processes. In the dorsal region there are rounded

fibrous bundles (fig. 184, [4]) passing between the extremities of the transverse processes of the middle vertebræ, and representing the intertransverse muscles of the lower spaces. In the neck they are absent.

Ligaments of special vertebræ.

Ligaments of Special Vertebræ. The description of the ligaments of the first two cervical, and of the sacral and coccygeal vertebræ, will be found with the dissection of the neck and of the pelvis.

Kinds of motion.

Movements of Spinal Column. The spinal column can be bent forwards, backwards, and to each side; and it can be rotated.

Flexion:

In *flexion*, the vertebræ between the axis and sacrum are inclined forwards. The greatest movement takes place between the lower lumbar vertebræ and the sacrum; there is an intermediate degree in the neck; and the least is in the upper half of the dorsal region, where the ribs are united to the sternum.

Fig. 184.—Ligaments of the Processes of the Vertebræ, and of the Ribs (Bourgery).

1. Supraspinous ligament.
2. Ligamentum subflavum.
3. Posterior costo-transverse ligament: on the opposite side the band has been removed and the joint opened.
4. Intertransverse ligament.

degree;

movement of bones;

The bodies of the bones are brought nearer together in front, while they are separated behind. The inferior pair of articular processes of the second vertebra glide upwards on the upper ones of the third; the inferior processes of the third bone move in like manner on the upper ones of the fourth; and so on throughout the moveable column.

state of ligaments.

The ligament in front of the bodies is relaxed, but the posterior and those uniting the neural arches and processes are tightened. The fore part of each intervertebral disc is compressed, and the back is stretched.

Extension: where most and least;

In *extension*, the column is arched backwards. The motion is most in the neck, and least in the dorsal vertebræ, which are fixed by the true ribs and the sternum, and are impeded in their movement by the overlapping spinous processes.

movement of bones;

The posterior parts of the vertebræ are approximated, while the anterior are separated; and the inferior articular processes of

each glide downwards on the upper ones of the next succeeding bone.

state of ligaments. The condition of the ligaments is the opposite to that in flexion. Thus, the intervertebral discs are compressed behind, and stretched in front; the spinous and subflaval ligaments are relaxed; the anterior common ligament of the bodies is tightened, and the hinder band is slackened.

Bending to side: extent; *Lateral inclination.* The spine can be curved to the right or the left side. Like the last movement, this bend is least in the more fixed upper dorsal vertebræ, and is greatest in the neck.

movement of bones; On the concave side of the curve, say the right, the bodies are brought nearer together; and they are carried away from each other on the opposite aspect. The right inferior articular surface glides down, and the left up, in the joints with the vertebra beneath.

state of ligaments. On the right side the ligaments will be relaxed and the intervertebral substance compressed; and on the left those structures will be tightened so as to check the movement.

Rotation: *Rotation* is the twisting of the bodies of the vertebræ around a vertical axis through their centres, the fore part being turned to

movement of bones; the right or left, while the lower articular processes glide in the opposite direction over the upper ones of the next bone below. The movement will obviously be checked by the tightening of one set of oblique fibres in the intervertebral disc.

where present. A pure rotation of this kind, however, takes place only to a small extent in the upper dorsal region; but in the neck a greater degree of turning movement is permitted in combination with lateral flexion, owing to the conformation of the articular surfaces. In the loins the articular surfaces are so disposed that rotation is impossible.

CHAPTER IX.

DISSECTION OF THE HEAD AND NECK.

Section I.

EXTERNAL PARTS OF THE HEAD.

Directions. In the dissection of the head and neck, the student should learn the parts described in this and the following Section, whilst the body is in the lithotomy position during the first three days of dissection.

Parts to be learnt whilst the body is in the lithotomy position.

The scalp is properly limited inferiorly, from behind forwards, by the external occipital protuberance, the superior curved line of the occipital bone and its prolongation along the temporal bone down to the tip of the mastoid process, by the temporal ridges on the parietal and frontal bones and by the supra-orbital margin ; but the dissection in this section extends downwards to the upper border of the zygoma.

Limits of the scalp.

Characteristics of the part. The skin of the scalp is firmly connected to the subjacent muscular and aponeurotic structures, and instead of the intermediate tissues consisting, as they do in most parts of the body, of a relatively loose, subcutaneous fascia, they are composed of dense tissue uniting the parts together. In this dense tissue the superficial nerves and vessels run ; the roots of the hairs project into it, and contained in its interstices is a certain amount of yellowish fat. It is an easy thing to reflect the skin, the superficial vessels and nerves and the aponeurotic tissues in a single layer, especially towards the upper part of the head. In order to avoid this the student should be very careful to keep the knife well directed to the skin, cutting through the hair roots, and as much as possible he should dissect from below upwards, for the blood vessels and nerves are larger below and smaller above.

Tough subcutaneous tissue.

Caution.

Position. The body having been placed on its back in the lithotomy position, the head should be raised to a suitable height by blocks under the neck, and the face turned towards the opposite side— this latter being done by mutual arrangements between the dissectors of the two sides.

Position.

Dissection. An incision should be made upwards behind the auricle along the line of its attachment, from the tip of the mastoid process below to the upper border of the auricle above, and it should then pass down the anterior attachment as far as the upper border of the zygoma. From this it should be prolonged forwards

Incisions.

along the upper border of the zygomatic arch and along the upper margin of the orbit as far as the root of the nose. A second incision should pass from the root of the nose, over the skull in the middle line to the external occipital protuberance behind. The flap of skin should be reflected upwards from below in front of the pinna and then be turned downwards behind that part as far as the superior curved line of the occipital bone.

Muscles of the ear.

EXTRINSIC MUSCLES OF THE EAR. Three muscles pass to the auricle from the side of the head. Two are above it,—one elevating, the other drawing it forwards; and the third, a retrahent muscle, is behind the ear. There are other special or intrinsic muscles of the cartilage of the ear, which will be afterwards noticed.

Dissection of upper muscles,

Dissection. If the auricle be drawn downwards by hooks, the position of the upper muscle will be indicated by a slight prominence between it and the head. By cleaning the slight ridge thereby produced, and removing a little areolar tissue, a thin fan-shaped layer of pale muscular fibres will come into view, the anterior portion of which is the *attrahens*, while the posterior is the *attollens aurem* muscle (fig. 185).

of posterior muscle.

On drawing forwards the ear, a ridge marks the situation of the posterior muscle, and the retrahens muscle must be sought beneath the subcutaneous tissue. It consists of rounded bundles of fibres, and is stronger and deeper than the others.

Attrahens aurem muscle.

The ATTRAHENS AUREM (fig. 185, [16]) is a small fan-shaped muscle which *arises* from the fore part of the aponeurosis of the occipito-frontalis. Its fibres are directed downwards and backwards, and are *inserted* into a projection on the front of the rim of the ear. Beneath it are the superficial temporal vessels and nerves.

Attollens aurem muscle.

The ATTOLLENS AUREM (fig. 185, [15]) has the same form as the preceding, though its fibres are longer and better marked. *Arising* also from the tendon of the occipito-frontalis, the fibres converge to their *insertion* into the inner or cranial surface of the pinna of the ear—into an eminence corresponding with a fossa (that of the antihelix) on the opposite aspect.

Retrahens aurem consists of two or three bundles.

The RETRAHENS AUREM (fig. 185, [17]) consists of two or three roundish but separate bundles of fibres, which are stronger than those of the other muscles. The bundles *arise* from the root of the mastoid process, and pass almost horizontally forwards to be *inserted* by tendinous fibres into the lower part of the ear (concha) on its cranial aspect. The auricular branches of the posterior auricular artery and nerve are in contact with this muscle.

Use of ear muscles.

Action. The three preceding muscles will move the outer ear slightly in the directions indicated by their names; the anterior drawing it upwards and forwards, the middle one upwards, and the posterior backwards.

Dissection. The muscular fibres of the occipitalis behind and of the frontalis in front are now to be cleaned according to their direction (fig. 185) and then the superficial vessels and nerves displayed in the following manner (fig. 186, p. 505).

Along the eyebrow seek the branches of vessels and nerves which come from the orbit, viz., the supraorbital vessels and nerve about the middle, and the supratrochlear nerve and frontal vessels near the inner angle of the orbit; they lie at first beneath the

Seek nerves and vessels on the forehead,

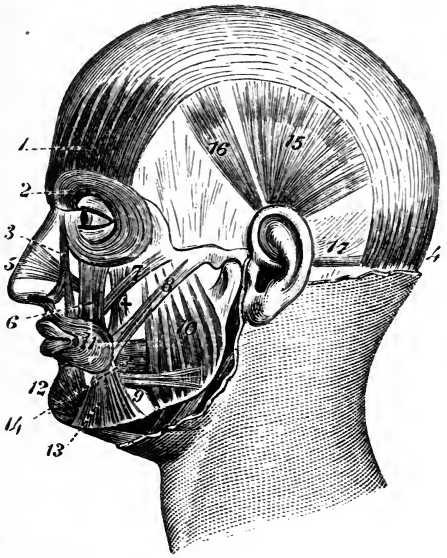


FIG. 185.—MUSCLES OF THE SCALP AND EAR.

1. Frontalis, and 4, occipitalis (the aponeurosis passing over the head between them).
2. Orbicularis palpebrarum.
3. Levator labii superioris alæque nasi.
5. Compressor naris.
6. Levator labii superioris.
7. Zygomaticus minor (too large).
8. Zygomaticus major.
9. Risorius.
10. Masseter.
11. Orbicularis oris.
12. Depressor labii inferioris.
13. Depressor anguli oris.
14. Buccinator.
15. Attollens aurem.
16. Attrahens aurem.
17. Retrahens aurem (only partly seen).
† Levator anguli oris.

muscular fibres of the frontalis, which must be cut through to find them.

On the side of the head, in front of the ear, the superficial temporal vessels and nerve are to be traced upwards; and, above the zygomatic arch, the branches of the facial nerve which join an offset of the superior maxillary are to be sought.

on the side of the head,

Behind the ear the posterior auricular vessels and nerve, and below it branches from the great auricular nerve to the tip and back of the pinna are to be found; one or more offsets of the last should be followed to its junction with the posterior auricular nerve.

behind ear,

At the back of the head the ramifications of the occipital vessels, and the large and small occipital nerves should be denuded; the

at the back of the head.

D. Frank P. Walsh

former nerve lies by the side of the artery, and the latter about midway between this vessel and the ear.

Occipito-frontalis.

The OCCIPITO-FRONTALIS MUSCLE (fig. 185, [1], [4]) covers the greater part of the vault of the skull, and consists of anterior and posterior fleshy parts with an intervening aponeurotic tendon.

Occipital part: origin and ending.

The *posterior part*, or the *occipitalis* ([4]), *arises* from the outer half or more of the upper curved line of the occipital bone, and from the mastoid portion of the temporal bone. The fibres are about one inch and a half in length, and ascend to the aponeurosis.

Frontal part: how attached.

The *anterior part*, or the *frontalis* ([1]), forms a thin layer which covers about the lower two-thirds of the frontal bone. Its fibres are paler than those of the occipital part, and spring from the aponeurosis some distance below the line of the coronal suture. They descend to the eyebrow and root of the nose, where they interlace with the fibres of the orbicularis palpebrarum, corrugator supercilii and pyramidalis nasi muscles (fig. 203, p. 553), and terminate in the subcutaneous tissue. Some fasciculi are frequently attached to the nasal bone internally, and to the external angular process of the frontal bone on the outer side. The right and left muscular portions meet at the lower part of the forehead.

Aponeurosis:

The *tendon of the occipito-frontalis*, or the *epicranial aponeurosis*, covers the upper part of the cranium, and is continuous across the middle line with the like structure of the opposite half of the head. In front, it sends a pointed process downwards for some distance between the two muscular portions; and behind, it is prolonged between the posterior bellies, to be attached to the occipital bone along the highest curved line. From its lateral margin the upper auricular muscles arise. Superficial to the aponeurosis are the vessels and nerves of the scalp and a small quantity of fat, which is traversed by numerous short fibrous bands uniting it closely to the skin. Its deep surface is connected to the pericranium only by a loose areolar tissue devoid of fat, so that the scalp moves freely over the skull.

its attachment,

and relations.

Prolongation to ear.

By making a transverse incision through the aponeurosis above the ear and separating it from the pericranium towards the side of the head, it will be seen to be joined by a thin membrane, which springs from the skull along the superior temporal line, and descends, closely united to the deep surface of the attollens aurem muscle, over the temporal fascia to be attached to the pinna of the ear.

Use of anterior and

posterior belly.

Action. When the anterior belly contracts it raises the eyebrow, smoothing the skin at the root of the nose, and wrinkling transversely that of the forehead; and continuing to contract, it draws forward the scalp. The posterior belly will move the scalp backwards; and the bellies acting in succession can carry the hairy scalp forwards and backwards.

Vessels of the scalp.

CUTANEOUS ARTERIES. The arteries of the scalp (fig. 186) are furnished by the internal and external carotid trunks, and anastomose freely over the side of the head. Only two small branches, the supraorbital and frontal, come from the internal

carotid; while three, viz., the superficial temporal, the occipital, and the posterior auricular, are derived from the external.

The SUPRAORBITAL ARTERY leaves the orbit through the notch in the margin of the orbit, and is distributed on the forehead. Some of its branches are superficial to the frontalis and supply the skin; while others lie beneath the muscle, and supply it, the pericranium, and the bone. Supraorbital artery.

The FRONTAL ARTERY is close to the inner angle of the orbit, and is much smaller than the preceding. It ends in branches for the supply of the muscles, integuments, and pericranium. Frontal artery.

The SUPERFICIAL TEMPORAL ARTERY (*d*) is one of the terminal branches of the external carotid. After crossing the zygoma immediately in front of the ear, the vessel divides on the temporal fascia into anterior and posterior branches. Superficial temporal has

The *anterior branch* runs forward with a serpentine course to the forehead, supplying muscular, cutaneous, and pericranial offsets, and anastomoses with the supraorbital artery; this is the branch that is opened when blood is taken from the temporal artery. anterior and

The *posterior branch* is larger than the other, and ascends to the top of the head, over which it anastomoses with the artery of the opposite side. Its offsets are similar to those of the anterior division, and communicate behind with the occipital and posterior auricular arteries. posterior branches.

OCCIPITAL ARTERY. The terminal part of this artery, appearing between the trapezius and sterno-mastoid muscles, divides into large and tortuous branches, which spread over the back of the head. Communications take place with the artery of the opposite side, with the posterior branch of the temporal, and with the posterior auricular artery. Some offsets pass deeply to supply the occipitalis muscle, the pericranium, and the bone. Occipital artery.

The POSTERIOR AURICULAR ARTERY (*f*) appears in front of the mastoid process, and divides into two branches. One (*mastoid*) is directed backwards to supply the occipitalis, and anastomoses with the occipital artery. The other (*auricular*) supplies the retrahent muscle, the back of the pinna, and the superficial structures above the ear: offsets from it also pierce the pinna to be distributed on the opposite surface. Posterior auricular artery.

The VEINS of the exterior of the head generally correspond to the arteries in their course, and communicate freely together, as well as with the sinuses in the interior of the skull by means of small branches named *emissary*, and with the veins of the diploë of the cranial bones. The *frontal vein* is of large size, and descends to the inner end of the eyebrow, beneath which it is joined by the smaller *supraorbital vein:* the resulting vessel is known as the *angular vein*, and it forms the commencement of the facial trunk. The *temporal vein* descends to the temporo-maxillary trunk; the *posterior auricular vein* to the external jugular; and the *occipital veins* join the deep veins at the back of the neck. Veins of the scalp.

CUTANEOUS NERVES (fig. 186). The nerves of the scalp are furnished from cutaneous offsets of both cranial and spinal nerves. Nerves of the scalp.

The half of the head in front of the ear receives branches from the three trunks of the fifth cranial nerve, and twigs to the muscles from the facial nerve. The skin of the hinder part of the head is supplied by spinal nerves (anterior and posterior primary branches); and close behind the ear, there is a muscular offset of the facial or seventh cranial nerve.

Supraorbital nerve:

The SUPRAORBITAL NERVE (fig. 186), comes from the first trunk of the fifth nerve, and escapes from the orbit with its companion artery. It is placed at first beneath the orbicularis palpebrarum and frontalis muscles, and here gives offsets to these as well as to the pericranium. In the orbicularis a communication is established between this and the facial nerve. Finally the nerve ends in two cutaneous branches.

its two cutaneous and

The inner of these soon pierces the frontalis, and reaches upwards as high as the parietal bone. The outer branch is of larger size, and perforating the muscle higher up, extends over the head as far as the ear.

palpebral branches.

As the nerves escapes from the supraorbital notch it furnishes some *palpebral* filaments to the upper eyelid.

Supratrochlear nerve:

At the inner angle of the orbit is the small SUPRATROCHLEAR NERVE (fig. 186), from the same trunk. It ascends to the forehead close to the bone and, piercing the muscular fibres, ends in the integument. Branches are given from it to the orbicularis and corrugator supercilii, and some *palpebral* twigs enter the upper eyelid.

palpebral branch.

Temporal nerves:

The SUPERFICAL TEMPORAL NERVES are derived from the second and third trunks of the fifth nerve, and from the facial nerve.

of superior maxillary;

The TEMPORAL BRANCH OF THE SUPERIOR MAXILLARY NERVE (second trunk of the fifth) is a slender twig (fig. 186), from the *temporo-malar nerve*, which perforates the temporal aponeurosis about a finger's breadth above the zygomatic arch. When cutaneous, the nerve is distributed on the fore part of the temple, and communicates with the facial nerve, also sometimes with the next.

of inferior maxillary,

The AURICULO-TEMPORAL NERVE (fig. 186, accompanying *d*), a branch of the inferior maxillary (third trunk of the fifth), makes its appearance with the temporal artery in front of the ear. As soon as it emerges from beneath the parotid gland, it divides into two terminal branches. The posterior is the smaller of the two, and supplies the integument above the ear. The anterior branch ascends vertically to supply the skin as far as the upper limit of the temporal fossa. The nerve also furnishes an *auricular branch* (upper) to the fore part of the ear above the auditory meatus.

its auricular branch;

and of facial nerve.

The TEMPORAL BRANCHES OF THE FACIAL NERVE are directed upwards over the zygomatic arch and the temporal aponeurosis to the orbicularis palpebrarum, corrugator supercilii and frontalis muscles: they will be described with the dissection of the facial nerve.

Posterior auricular nerve has

The POSTERIOR AURICULAR NERVE (fig. 186) lies behind the ear with the artery of the same name. It arises from the facial nerve close to the stylo-mastoid foramen, and ascends in front of the mastoid process. Soon after the nerve becomes superficial it

communicates with the great auricular nerve, and divides into occipital and auricular branches.

The *occipital branch* is long and slender, and ends in the posterior occipital branch,

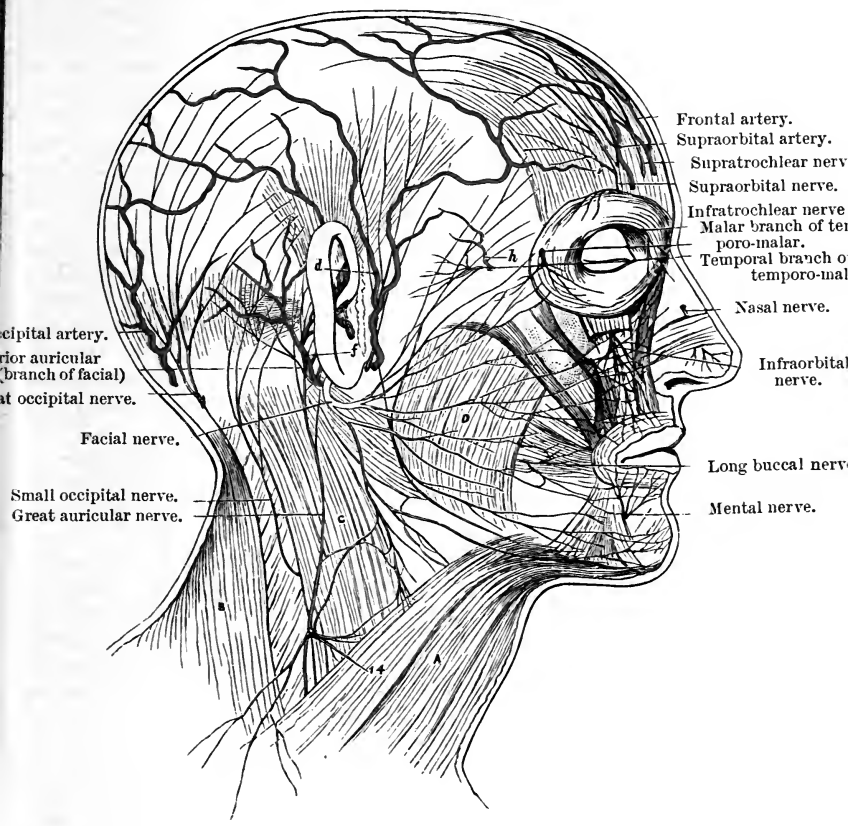


FIG. 186.—NERVES AND ARTERIES OF THE SCALP.

d. Superficial temporal artery.
f. Posterior auricular artery.
h. Orbital branch of superficial temporal artery.
14. The superficial cervical nerve.
A. Platysma muscle.
B. Trapezius muscle.
C. Sterno-mastoid muscle.
D. Masseter muscle.

The auriculo-temporal nerve is shown running up with the superficial temporal artery (*d*).

belly of the occipito-frontalis muscle. It lies close to the bone, enveloped in dense fibrous structure.

The *auricular branch* ascends to the back of the ear, supplying the retrahent muscle and the small muscles on the posterior surface of the pinna. and auricular.

Great auricular nerve.

The GREAT AURICULAR NERVE, from the anterior divisions of the second and third cervical nerves in the cervical plexus (fig. 186), is seen to some extent at the lower part of the ear, but its anatomy will be afterwards given with the description of the cervical plexus.

Great occipital nerve:

The GREAT OCCIPITAL (fig. 186) is the largest cutaneous nerve at the back of the head, and lies close to the occipital artery. It is the internal branch of the *posterior* primary branch of the second cervical nerve; it perforates the muscles of the back of the neck, and divides on the occiput into numerous large offsets; these spread over the posterior part of the head, and terminate in the

junctions.

integument. As soon as the nerve pierces the trapezius, it is joined by an offset from the third cervical nerve; and on the back of the head it communicates with the small occipital nerve.

Small occipital nerve

The SMALL OCCIPITAL NERVE, from the *anterior* divisions of the second and third cervical nerves in the cervical plexus (fig. 186), lies midway between the ear and the preceding nerve, and is continued upwards in the integuments higher than the level of the ear. It communicates with the nerve on each side, viz., the

has an auricular branch.

posterior auricular and the great occipital. Usually this nerve furnishes an *auricular branch* to the upper part of the pinna on its cranial aspect.

How to see temporal fascia.

Dissection. The upper auricular muscles and the temporal vessels, together with the epicranial aponeurosis and its lateral prolongation, will now be removed in order that the attachment of the temporal fascia on the side of the head may be seen.

Temporal fascia:

The *temporal fascia* is a white, shining membrane, which is stronger than the epicranial aponeurosis, and gives attachment to

attachments,

the subjacent temporal muscle. Superiorly it is inserted into the curved line that limits the temporal fossa on the side of the skull; and inferiorly, where it is narrower and thicker, it is fixed to the

relations,

zygomatic arch. By its cutaneous surface the fascia is in contact with the muscles already examined, and with the superficial temporal vessels and nerves.

and layers.

An incision in the fascia, a little above the zygoma, will show it to consist there of two layers, which are fixed to the edges of the upper border of the zygomatic arch. Between the layers is some fatty tissue, with a small branch of the superficial temporal artery, and a slender twig of the orbital branch of the superior maxillary nerve with an accompanying artery.

To see temporal muscle.

Dissection. The temporal fascia is now to be detached from the skull, and to be thrown down to the zygomatic arch, in order that the origin of the underlying temporal muscle may be examined. The soft areolar tissue which lies beneath it near the zygoma is to be taken away. The difference in thickness of the parts of the fascia will be evident.

Temporal muscle:

The TEMPORAL MUSCLE is laid bare only in part. Wide and thin above, it becomes narrower and thicker below. It *arises*

origin,

from the temporal fascia, and from the surface of the impression on the side of the skull, which is named the temporal fossa. From this origin the fibres descend and converge to a tendon,

which is *inserted* into the margins and inner surface of the coronoid process of the lower jaw. insertion, and

On the cutaneous surface is the temporal fascia, with the parts superficial to that membrane; and concealed by the muscle are the deep temporal vessels and nerves which ramify in it. The insertion of the muscle will be seen, and its action explained, in the dissection of the pterygoid region. relations.

Section II.

INTERNAL PARTS OF THE HEAD.

Dissection. The skull is now to be opened by the workers on both sides of the head acting jointly, but before sawing through the bone the dissector should detach the temporal muscle nearly down to the zygoma; all the remaining soft parts are to be divided by an incision carried round the skull, about one inch above the margin of the orbit at the forehead, and about the same distance above the protuberance of the occipital bone behind. Dissection to open the skull.

The cranium is to be sawn in the same line as the incision through the soft parts, but the saw is to cut only through the outer table of the bone. The student will know when he has reached the diploë by the material on the saw becoming red. The inner table is then to be broken through with a chisel, in order that the subjacent membrane of the brain (dura mater) may not be injured. The skullcap is next to be forcibly detached by inserting the hooked part of the handle of the chisel between the cut surfaces of bone in front and pulling the shell of bone off backwards. The dura mater will then come into view. Precautions in cutting through the bone.

The DURA MATER is the most external of the membranes investing the brain. It is a strong, fibrous structure, which serves as an internal periosteum to the bones, and supports the cerebral mass. Its outer surface is rough, and presents, now the bone is separated from it, numerous small fibrous and vascular processes; but these are most marked along the line of the sutures, where the attachment of the dura mater to the bone is more intimate. Ramifying on the exposed part of the membrane are branches of the large meningeal vessels. Dura mater; appearance of outer surface.

Small granular masses, Pacchionian bodies, are also seen close to the middle line. The number of these bodies is very variable; they are seldom found before the third year, but generally after the seventh, and they increase with age. The surface of the skull is frequently indented by those bodies, especially on the back part of the parietal bone. Pacchionian bodies.

Dissection. For the purpose of seeing the interior of the dura mater, divide this membrane with scissors close to the margin of the skull, except in the middle line before and behind, where the superior longitudinal sinus lies. The cut membrane Cut through dura mater.

is then to be raised on the right side towards the top of the head ; and the veins connecting it with the brain may be broken through.

Inner surface

The inner surface of the dura mater is free and smooth, being separated from the arachnoid (the second of the coverings of the brain) by the cavity known as the *subdural space*, although the two membranes are in the natural condition closely applied to one another. The fibrous tissue of which the dura mater is composed is so arranged as to give rise to two strata, an external (or *periosteal*) which adheres to the bones, and an internal (or *meningeal*) which is lined by an epithelium similar to that on serous membranes. At certain spots these layers are slightly separated, and form thereby the spaces or sinuses for the passage of the venous blood.

and structure.

Processes.

Moreover, the innermost layer sends processes between different parts of the brain, forming the falx, tentorium, &c.

Falx cerebri:

The *falx cerebri* (fig. 187, p. 512) is the median sickle-shaped process of the dura mater, which dips in between the hemispheres of the large brain. Its form and extent will be evident if the right half of the brain is gently separated from it. Narrow in front, where it is attached to the crista galli of the ethmoid bone, it widens behind, and joins a horizontal piece of the dura mater named the tentorium cerebelli. Its upper border is convex, and is fixed to the middle line of the skull as far backwards as the internal occipital protuberance ; and the lower or free border is concave and turned towards the central portion of the brain (corpus callosum), with which it is in contact inferiorly.

form and attachments ;

borders ;

sinuses in it.

In this fold of the dura mater are contained the following *sinuses* :—the *superior longitudinal* along the convex border, the *inferior longitudinal* in the hinder part of the lower edge, and the *straight* sinus at the line of junction between it and the tentorium (fig. 187).

Superior longitudinal sinus:

The SUPERIOR LONGITUDINAL SINUS (fig. 187, *b*) extends from the ethmoid bone in front to the internal occipital protuberance behind. Its position in the convex border of the falx will be made manifest by the escape of blood through numerous small veins, when pressure is made from before backwards with the finger along the median part of the dura mater.

Dissection. The sinus is now to be opened by cutting into it from above along the middle line and by detaching the dura from the bone down to the internal occipital protuberance behind.

situation and ending ;

its interior ;

When the sinus is opened it is seen to be narrow in front, and to widen behind, where it ends in a dilatation termed the *torcular Herophili* on one side (more frequently the right) of the internal occipital protuberance. Its cavity is triangular in form, with the apex of the space turned to the falx ; and across it are stretched small tendinous cords—*chordæ Willisii*—near the openings of some of the cerebral veins. Frequently small Pacchionian bodies project into the sinus.

veins opening into it.

The sinus receives small veins from the substance of the skull and dura mater, and larger ones from the brain ; and the blood

flows backwards in it. The cerebral veins open chiefly at the posterior part of the canal, and they lie for some distance against the wall of the sinus before they perforate the dura mater; their course is directed from behind forwards, so that the current of the blood in them is opposed to that in the sinus: this disposition of the veins may be seen on the left side of the brain, where the parts are undisturbed.

Directions for removal of brain.

DIRECTIONS. Before the rest of the dura mater can be examined, the brain must be taken from the head. To facilitate its removal, let the head incline backwards, while the shoulders are raised on a block, so that the brain may be separated somewhat from the base of the skull. For the division of the cranial nerves a sharp scalpel will be necessary; and the nerves are to be cut longer on the one side than the other.

Mode of proceeding, and parts cut in succession.

Removal of the Brain. As a first step cut across the anterior part of the falx cerebri, and the different cerebral veins entering the longitudinal sinus; raise and throw backwards the falx, but leave it uncut behind. Gently lift up the frontal lobes and the olfactory bulbs of the large brain. Next cut through the *internal carotid artery* (fig. 189) and the *second* and *third nerves*, which then appear, together with some veins descending from the brain; the large second nerve is placed on the inner, and the round third nerve on the outer side of the artery.

Anterior vessels and nerves,

The brain is now to be supported in the left hand, and the pituitary body to be dislodged with the knife from the hollow in the centre of the sphenoid bone. A strong horizontal process of the dura mater (tentorium cerebelli) then comes into view at the back of the cranium. Along its free margin lies the small *fourth nerve*, which is to be cut at this stage of the proceeding. Make an incision through the tentorium on each side, close to its attachment to the temporal bone, without injuring the parts underneath: the following nerves, which will be then visible, are to be divided in succession. Near the inner margin of the tentorium is the *fifth nerve*, consisting of a large and small root; while nearer the median plane is the slender *sixth nerve*. Below the fifth and somewhat external to it, are the *seventh and eighth nerves* entering the internal auditory meatus, the former being anterior and the smaller of the two. Directly below the foregoing are the *ninth, tenth and eleventh* nerves in one line:—of these the upper small piece is the ninth or the glosso-pharyngeal; the flat band next below, the tenth or pneumo-gastric; and the long round nerve ascending from the spinal canal, the eleventh or spinal accessory. The remaining nerve near the median plane is the *twelfth*, which consists of two small pieces.

next the tent,

posterior nerves and

After dividing the nerves, cut through the *vertebral arteries* as they wind round the medulla oblongata. Lastly, cut across the *spinal cord* as low as possible, as well as the roots of the spinal nerves that are attached on each side. Then on placing the first two fingers of the right hand in the spinal canal, the short upper portion of the cord may be raised, and the whole brain may be

vessels, and

lastly, the spinal cord.

taken readily from the skull in the two hands. In doing this some large veins, passing from the hinder part of the cerebral hemisphere to the attached margin of the tentorium, will be broken through, as well as small ones from the portions of the brain in the posterior fossa of the base of the skull.

How to preserve the brain.

PRESERVATION OF THE BRAIN. After removing some of the membranes from the upper part, and making a few apertures through them on the under surface so that the liquid may have free access, the brain may be hardened by immersion in a 5 per cent. solution of formalin in water. Wrap the brain up in a piece of calico, and then place it upside down in a suitable vessel, on the bottom of which some cotton-wool or tow has been spread, and let it be quite covered with the liquid, and insert a little tow or cotton wool between the cerebellum and the occipital lobes.

Examination of it.

EXAMINATION OF THE BRAIN. At the end of two or three days the dissectors should examine the other membranes of the brain and the vessels as described in Section 1 of The Brain. As soon as the vessels have been learnt, the membranes are to be carefully removed from the surface of the brain, without detaching the different cranial nerves at the under surface. The brain may then remain in the preservative liquid till the dissection of the head and neck has been completed, but it should be turned over occasionally to allow the fluid to penetrate its substance, and a little extra formalin added from time to time as fully directed in the Section referred to.

Directions.

Directions. After setting aside the brain, the anatomy of the dura mater, and the vessels and nerves in the base of the skull should be proceeded with. For this purpose raise the head to a convenient height, and fasten the tentorium in its natural position with a few stitches. The dissector should be furnished with the base of a dried skull while studying the following parts.

Dura mater in base of skull:

Dura mater. At the base of the cranium the dura mater is much more closely united to the bones than it is at the top of the skull. Here it follows the different inequalities of the osseous surfaces and sends processes through the several foramina, which join for the most part the pericranium, and furnish sheaths to the nerves.

its prolongations,

Beginning the examination in front, the membrane will be found to send a prolongation into the foramen cæcum, as well as a series of tubes through the apertures in the cribriform plate of the ethmoid bone. Through the sphenoidal fissure it joins the periosteum of the orbit; and through the optic foramen a sheath is

and connections to bone.

continued on the optic nerve to the eyeball. In the sella turcica the dura mater forms a recess which lodges the pituitary body, and behind the dorsum sellæ it adheres closely to the basilar process of the occipital bone. From the latter part it may be traced into the spinal canal through the foramen magnum, to the margin of which it is very firmly united.

Tentorium cerebelli:

The *tentorium cerebelli* is the process of the dura mater which is interposed in a somewhat horizontal position between the small

brain (cerebellum) and the posterior part of the large brain (cerebrum).

surfaces,

Its upper surface is raised along the middle, where it is joined by the falx cerebri, and is sloped laterally for the support of the back part of the cerebral hemispheres. Its under surface rests on the small brain, and is joined by the falx cerebelli.

edges,

The anterior concave margin is free, except at the ends where it is fixed by a narrow slip to each anterior clinoid process. The posterior or convex edge is connected to the following bones:—the occipital (transverse groove), the posterior inferior angle of the parietal, the petrous portion of the temporal (upper border), and the posterior clinoid process of the sphenoid.

and the sinuses in it.

Along the centre of the tentorium is the straight sinus; and in the attached edge are the lateral and superior petrosal sinuses on each side.

Falx cerebelli

The *falx cerebelli* has a corresponding position below the tentorium to the falx cerebri above that fold. It is much smaller than the falx of the cerebrum, and will appear on detaching the tentorium. Triangular in form, this fold is adherent to the internal occipital crest, and projects between the hemispheres of the small brain. Its base is directed to the tentorium; and the apex reaches the foramen magnum, on each side of which it gives a small slip. In it is contained the occipital sinus.

contains occipital sinus.

Sinuses of the skull.

The SINUSES are channels for venous blood between the layers of the dura mater. They are arranged in two groups, the one comprising the sinuses that converge towards the internal occipital protuberance, while the other is formed by the cavernous sinuses on the sides of the body of the sphenoid bone and the canals opening into these.

Superior and inferior longitudinal.

A. The *superior longitudinal sinus* has been described at p. 508.

The INFERIOR LONGITUDINAL SINUS (fig. 187, *c*) resembles a small vein, and is contained in the lower border of the falx cerebri at the posterior part. It receives blood from the falx and the large brain, and ends in the straight sinus (*d*) at the edge of the tentorium.

Straight sinus.

The STRAIGHT SINUS (fig. 187, *d*) lies along the junction of the falx with the tentorium, extending from the termination of the preceding sinus to the internal occipital protuberance, where it is continued into one of the lateral sinuses, generally the left. Its form is triangular, like the superior longitudinal. Joining it are the inferior longitudinal sinus, the veins of Galen (which will be seen to be cut or torn offshort) from the interior of the cerebral hemispheres, and some small veins from the upper surface of the cerebellum.

Occipital sinus.

The OCCIPITAL SINUS (fig. 187, *g*) is a small canal in the falx cerebelli, which reaches from the torcular Herophili to the foramen magnum and collects the blood from the lower occipital fossæ. This sinus may be double.

Lateral sinuses:

The LATERAL SINUSES, right and left, are the channels by which most of the blood passes from the skull. Each extends from the internal occipital protuberance, along the winding groove on the

difference on two sides,

occipital, parietal and temporal bones, to the jugular foramen, where it ends in the internal jugular vein. The sinus of the right side is generally larger than the left, and begins at the torcular Herophili behind, forming, usually, the continuation of the superior longitudinal sinus. The left lateral sinus is mainly prolonged from the ending of the straight sinus, but it is also joined by a branch from the lower end of the superior longitudinal sinus, which crosses obliquely in front of the occipital protuberance. In some cases this arrangement is reversed, so that the torcular Herophili and the larger lateral sinus are placed on the left side; and occasionally the torcular Herophili forms a common place of the meeting (confluence) of the superior longitudinal, the straight and the two lateral sinuses.

and tributaries.

The lateral sinus is joined by some cerebral and cerebellar veins,

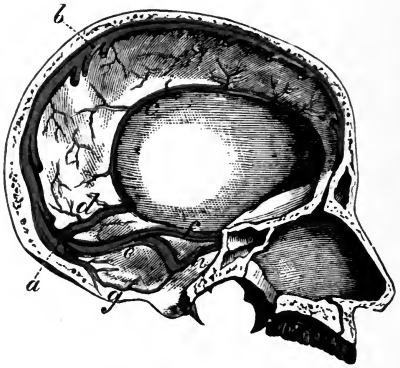


Fig. 187.—Some of the Venous Sinuses of the Skull.

a. Torcular Herophili.
b. Superior, *c*. Inferior longitudinal sinus.
d. Straight sinus.
e. Lateral sinus.
g. Occipital sinus.
f. Superior, and *h*. Inferior petrosal sinus.

and, opposite the upper edge of the petrous portion of the temporal bone, by the superior petrosal sinus. It communicates with the occipital veins through the mastoid foramen, and often with the deep veins of the neck through the posterior condylar foramen.

Subdivision of the jugular foramen.

The jugular foramen is divided into three compartments by fibrous bands. Through the posterior opening the lateral sinus passes; through the anterior the inferior petrosal sinus: and through the central one the ninth, tenth, and eleventh nerves.

Dissection.

Dissection. The dissectors should first examine the cavernous sinus on the left side. Cut through the dura mater by the side of the body of the sphenoid bone from the anterior to the posterior clinoid process, and internal to the position of the third nerve; behind the clinoid process, let the knife be directed inwards for about half the width of the basilar part of the occipital bone. By

placing the handle of the scalpel in the opening thus made, the extent of the space will be defined. A probe or a blow-pipe will be required, in order that it may be passed into the different sinuses joining the cavernous centre, and these should then be opened up.

Cavernous sinus

B. The CAVERNOUS SINUS, which has been so named from the reticulate structure in its interior, is situate on the side of the body of the sphenoid bone. This space, resulting from the separation of the two layers of the dura mater, is of an irregular shape, and extends from the sphenoidal fissure to the tip of the petrous portion of the temporal bone.

has nerves in outer wall;

The layer of dura mater bounding the sinus externally is of some thickness, and contains in its substance the third and fourth nerves, with the ophthalmic and superior maxillary trunks of the fifth nerve: these lie in the order given from above downwards.

contains carotid artery and sixth nerve:

The cavity of the sinus is larger behind than before, and is traversed by a network of slender fibrous cords. Through the space winds the trunk of the internal carotid artery surrounded by the sympathetic, with the sixth nerve running forwards on the outer side of the vessel; but all these are bound to the outer wall of the sinus, and separated from the blood in the space by a thin lining membrane.

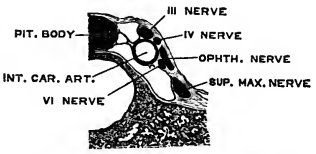


FIG. 188.—TRANSVERSE SECTION OF THE CAVERNOUS SINUS (AFTER LANGER).

tributaries and communications.

The cavernous sinus receives the ophthalmic veins from the orbit through the sphenoidal fissure, and some inferior cerebral veins. It communicates with its fellow of the opposite side by the intercavernous sinuses, and with the pterygoid plexus outside the skull through the foramen ovale and the foramen lacerum. The blood leaves the chamber by the superior and inferior petrosal sinuses.

Intercavernous or circular sinus.

The INTERCAVERNOUS SINUSES are two vessels which pass transversely in the sella turcica between the right and left cavernous sinuses, being placed one in front of, and the other behind the pituitary body. To the venous ring thus formed around the pituitary body the name of *Circular sinus* has been given.

Superior petrosal.

The SUPERIOR PETROSAL SINUS (fig. 187, *f*) lies in a groove in the upper edge of the petrous part of the temporal bone, and extends between the cavernous and lateral sinuses. Small veins from the cerebellum are received into it.

Inferior petrosal.

The INFERIOR PETROSAL SINUS (fig. 187, *h*) is larger than the superior, and lies in a groove along the line of junction of the petrous part of the temporal with the basilar process of the occipital bone; it is joined by small veins from the cerebellum, and one from the internal ear. This sinus passes through the anterior compartment of the jugular foramen, and ends in the internal jugular vein.

Basilar plexus.

The BASILAR SINUS or PLEXUS is a venous network in the substance of the dura mater over the basilar process of the occipital bone, uniting the inferior petrosal sinuses.

Arteries of dura mater are:—

MENINGEAL ARTERIES. These arteries supplying the cranium and the dura mater come through the base of the skull; they are named from their situation in the three fossæ, anterior, middle, and posterior.

Anterior meningeal.

The ANTERIOR MENINGEAL are small branches of the anterior ethmoidal artery, which enters the skull by the anterior internal orbital canal. Its meningeal branches are distributed to the dura mater over and near the ethmoid bone.

Middle meningeal.

The MIDDLE MENINGEAL ARTERIES are three in number: two of them, named large and small, are derived from the internal maxillary trunk; and the third is an offset of the ascending pharyngeal artery.

Large from internal maxillary

a. The *large meningeal artery* (often simply called the *middle meningeal artery*) from the internal maxillary appears through the foramen spinosum of the sphenoid bone, and divides into two principal branches. The larger of these passes to the deep groove on the anterior inferior angle of the parietal bone, and ends in ramifications which extend upwards to the top of the head and forwards over the frontal bone. The posterior branch is distributed over the hinder part of the parietal and the upper part of the occipital bones. Two *veins* accompany this artery.

gives branches to dura mater and bone.

As soon as the artery comes into the cranial cavity, it furnishes branches to the dura mater and to the ganglion of the fifth nerve. One small offset, *petrosal*, enters the hiatus Fallopii, and supplies the surrounding bone. One or two branches pass through the sphenoidal fissure into the orbit, and anastomose with the ophthalmic artery.

Small meningeal.

b. The *small meningeal branch* is an offset of the large one outside the skull, and is transmitted through the foramen ovale to the membrane lining the middle cranial fossa.

One from ascending pharyngeal.

c. Another *meningeal branch* from the ascending pharyngeal artery comes through the foramen lacerum (basis cranii). This is seldom injected, and is not often visible.

Posterior meningeal.

The POSTERIOR MENINGEAL ARTERIES are small twigs of the ascending pharyngeal which enter the skull by the anterior condylar and jugular foramina, and supply the dura mater in that neighbourhood: also a branch of the vertebral artery is distributed over the lower part of the occipital bone. The branch coming through the jugular foramen is sometimes derived from the occipital artery.

Nerves of dura mater.

MENINGEAL NERVES. Offsets to the dura mater are derived from the fifth, tenth and twelfth cranial nerves, and from the sympathetic.

Cranial nerves in the base of the skull:

CRANIAL NERVES (fig. 189, p. 515). As the cranial nerves pass through their apertures in the base of the skull they are invested by processes of the membranes of the brain, which are thus disposed:—those of the dura mater and pia mater are continued into the sheath of the nerve; while that of the arachnoid, except in the

case of the second nerve, terminates as the nerve enters the dura mater. Some of the nerves in the middle fossa of the skull pierce the dura mater before they reach the foramina of exit. The nerves are arranged in twelve pairs, which are enumerated from before backwards in the order in which they perforate the dura mater. Only part of the intracranial course of each nerve will be seen at this stage; the rest will be learnt in the dissection of the base of the brain.

only partly seen.

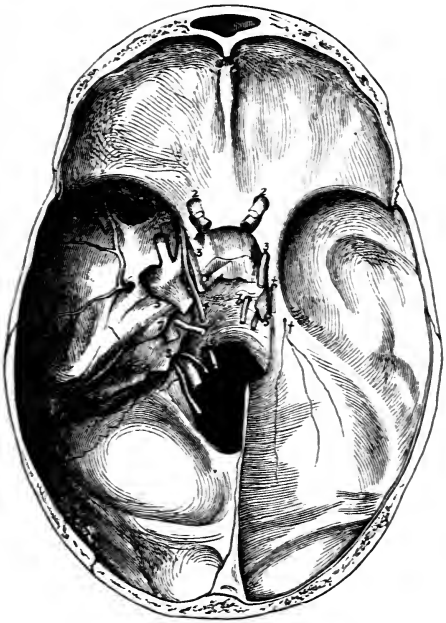


FIG. 189.—CRANIAL NERVES IN THE BASE OF THE SKULL. ON THE LEFT SIDE THE DURA MATER HAS BEEN REMOVED FROM THE MIDDLE FOSSA TO SHOW THE NERVES IN THE WALL OF THE CAVERNOUS SINUS, THE GASSERIAN GANGLION, AND THE THREE TRUNKS OF THE FIFTH NERVE.

2, 3, 4, 5, 6. Second to sixth nerves.
7. Facial and auditory.
8. Glosso-pharyngeal, vagus and spinal accessory.
9. Hypoglossal. On the right side the dura mater is untouched.
† Offset to the tentorium from the ophthalmic nerve.

The FIRST OR OLFACTORY NERVES are about twenty small filaments which arise from the olfactory bulb of the brain as it lies in the groove at the side of the crista galli, and descend to the nose through the foramina in the cribriform plate of the ethmoid bone.

Olfactory nerves end in the nose.

The SECOND OR OPTIC NERVE (fig. 189, 2), diverging to the eyeball from its commissure, enters the orbit through the optic foramen. It is accompanied by the ophthalmic artery.

Second nerve passes to the eye.

Dissection of third and fourth nerves;

Dissection. The third and fourth nerves, and the ophthalmic trunk of the fifth nerve, lie in the outer wall of the cavernous sinus; and to see them, it will be necessary to trace them through the dura mater towards the orbit.

of fifth nerve.

Afterwards the student should follow outwards the roots of the fifth nerve into the middle fossa of the skull, as in fig. 189, taking away the dura mater from them, and from the surface of the large Gasserian ganglion which lies on the fore part of the petrous portion of the temporal bone. From the front of the ganglion arise two other large trunks beside the ophthalmic, viz., superior and inferior maxillary, and these should also be traced to their apertures of exit from the skull. If the dura mater is removed entirely from the bone near the nerves a better view will be obtained. Some of the nerves may have been injured by the previous opening of the left cavernous sinus, and if that be so, the dissectors should jointly examine the right side.

Third nerve

The THIRD OR OCULOMOTOR NERVE (fig. 189, [3]) is destined for the muscles of the orbit. It enters the wall of the cavernous sinus near the anterior clinoid process, and is placed at first above the other nerves; but when it is about to enter the orbit through the sphenoidal fissure, it sinks below the fourth and part of the fifth, and divides into two branches.

passes to orbit.

Near the orbit the nerve is joined by one or two delicate filaments from the cavernous plexus of the sympathetic.

Fourth nerve

The FOURTH OR TROCHLEAR NERVE (fig. 189, [4]) courses forwards to one muscle in the orbit. It is the smallest of the cranial nerves, and pierces the dura mater at the free edge of the tentorium, close

in the wall of sinus.

behind the posterior clinoid process. In the wall of the sinus it lies below the third; but as it is about to pass through the sphenoidal fissure it rises higher than all the other nerves.

While in the wall of the sinus the fourth nerve is joined by twigs of the sympathetic.

Fifth nerve has two roots.

FIFTH OR TRIFACIAL NERVE (fig. 189, [5]). This nerve is distributed to the face and head, and consists of two parts or roots—a large or sensory, and a small or motor.

Large root,

The *large root* of the nerve passes through an aperture in the dura mater into the middle fossa of the base of the skull, where it immediately enters the Gasserian ganglion. The hollow wherein the

Cavum Meckelii, and Gasserian ganglion on it;

ganglion is lodged is known as the Cavum Meckelii.

The *Gasserian ganglion*, placed in a depression close to the apex of the petrous part of the temporal bone, is flattened, and about half an inch wide. The upper surface of the ganglion is closely united to the dura mater, and presents a semilunar elevation, the convexity of which looks forward. Some filaments from the plexus of the sympathetic on the carotid artery join its inner side.

gives three branches.

Branches. From the front of the ganglion proceed the three following trunks:—The *ophthalmic nerve*, the first and highest, is destined for the orbit and forehead. Next in order is the *superior maxillary nerve*, which leaves the skull by the foramen rotundum,

and ends in the face below the orbit. And the last, or the *inferior maxillary nerve*, passes through the foramen ovale to reach the lower jaw, the lower part of the face, and the tongue.

The *small root* of the fifth nerve, lying in the same tube of the dura mater as the large one, passes beneath the ganglion without communicating with it, and joins only one of the three trunks derived from the ganglion: if the ganglion be raised, this root will be seen to enter the inferior maxillary nerve. Small root.

Those branches of the ganglion which are unconnected with the small or motor root, viz., the ophthalmic and superior maxillary, are solely nerves of sensibility; but the inferior maxillary, which is compounded of both roots, is a nerve of sensibility and motion. It will moreover be subsequently seen that the fibres of the motor root are almost entirely confined to that part of the inferior maxillary nerve which supplies the muscles of the lower jaw, and that the larger branches of the nerve are wholly sensory in function. Difference in the use of the roots.

The *ophthalmic nerve* is the only one of the three trunks which needs a more special notice in this stage of the dissection. It is continued through the sphenoidal fissure and the orbit to the forehead. In form it is a flat band, and is contained in the wall of the cavernous sinus below the third and fourth nerves. Near the orbit it divides into three branches, *frontal*, *nasal*, and *lachrymal*. Ophthalmic nerve enters orbit;

In this situation it is joined by filaments of the cavernous plexus of the sympathetic, and gives a small *recurrent* filament (fig. 189, †) to the tentorium cerebelli. supplies dura mater in its course.

The SIXTH or ABDUCENT NERVE (fig. 189, 6) enters the orbit through the sphenoidal fissure, and supplies one of the orbital muscles. It pierces the dura mater behind the body of the sphenoid bone in the wall of the inferior petrosal sinus, and crosses the space of the cavernous sinus, to gain the outer wall with the other nerves. Sixth nerve is in cavernous sinus;

In the sinus the nerve is placed close against the outer side of the carotid artery; and it is joined by one or two large branches of the sympathetic nerve surrounding that vessel. joins sympathetic.

The SEVENTH or FACIAL and the EIGHTH or AUDITORY NERVES (fig. 189, 7) pass together into the internal auditory meatus, the facial being the smaller and higher of the two. At the bottom of the meatus they separate; the facial nerve courses through the aqueduct of Fallopius to the face, and the auditory nerve is distributed to the internal ear. Seventh and eighth nerves leave skull together.

The NINTH or GLOSSO-PHARYNGEAL, the TENTH, PNEUMO-GASTRIC or VAGUS, and the ELEVENTH or SPINAL ACCESSORY NERVES (fig. 189, 8) pass through the middle compartment of the jugular foramen. The glosso-pharyngeal is external to the other two, and has a distinct opening in the dura mater. The spinal accessory nerve ascends through the foramen magnum and, together with the vagus, enters an aperture in the dura mater close to the occipital bone. Ninth, tenth and eleventh nerves pass through jugular foramen.

The TWELFTH or HYPOGLOSSAL NERVE (fig. 189, 9) is the motor nerve of the tongue, and consists of two small pieces, which pierce Twelfth nerve.

the dura mater separately opposite the anterior condylar foramen ; these unite at the outer part of that aperture.

Dissection of carotid ;

Dissection. The dissector should now turn to the examination of the trunk of the carotid artery as it winds through the cavernous sinus.

of sympathetic plexuses,

An attempt should be made to find two small *plexuses* of the sympathetic on the carotid artery, though in a well-injected body this dissection is scarcely possible.

cavernous and carotid.

One of these (cavernous) is near the root of the anterior clinoid process ; and to bring it into view it will be necessary to cut off that piece of bone, and to dissect out with care the third, fourth, fifth, and sixth nerves, looking for filaments between them and the plexus. Another plexus (carotid), joining the fifth and sixth nerves, surrounds the artery as it enters the sinus.

Internal carotid artery

The INTERNAL CAROTID ARTERY appears in the cranium at the apex of the petrous part of the temporal bone. In this part of its course the vessel lies between the layers of the dura mater bounding the cavernous sinus along the side of the body of the sphenoid bone, and makes two bends so as to have the form of the letter S reclined. It first ascends in the inner part of the foramen lacerum, and then runs forward to the root of the anterior clinoid process ; finally it turns upwards in the groove on the inner side of this process, perforates the dura mater forming the roof of the sinus, and divides into cerebral arteries at the base of the brain. In this course the artery is enveloped by nerves derived from the sympathetic in the neck.

winds through cavernous sinus.

Branches.

The *branches* of the artery here are some small twigs (arteriæ receptaculi) for the supply of the dura mater and the bone, the nerves and the pituitary body, and, opposite the anterior clinoid process, the *ophthalmic artery*.

The terminal branches of the carotid will be seen in the dissection of the base of the brain.

Sympathetic forms

SYMPATHETIC NERVE. Accompanying the carotid artery is a prolongation of the sympathetic nerve of the neck, which forms the following plexuses :—

carotid plexus,

The *carotid plexus* is situate on the outer side of the vessel, at its entrance into the cavernous sinus, and communicates with the sixth nerve and the Gasserian ganglion.

cavernous plexus,

The small *cavernous plexus* is placed below the bend of the artery which is close to the anterior clinoid process, and is mainly derived from that offset of the upper cervical ganglion which courses along the inner side of the carotid artery. Filaments from the plexus unite with the third, fourth, and ophthalmic nerves. One filament is also furnished to the lenticular ganglion in the orbit, either separately from, or in conjunction with the nasal nerve.

union with cranial nerves.

Distribution.

After forming these plexuses, the nerves surround the trunk of the carotid, and are continued on the cerebral and ophthalmic branches of that vessel.

Two superficial petrosal nerves.

PETROSAL NERVES. Beneath the Gasserian ganglion is the *large superficial petrosal nerve* (fig. 240, [2], p. 678) entering the hiatus

Fallopii to join the facial nerve. External to this is sometimes seen the *small superficial petrosal nerve* (fig. 240, [3]), but this is frequently concealed in the substance of the temporal bone. The source and destination of these small nerves will be afterwards learnt. It will suffice now for the student to notice their position, and to see that they are kept moist and fit for examination at a future time.

Directions. When the study of the base of the skull has been completed a preservative fluid should be applied, and the flaps of skin should be stitched together over all. Directions for preserving parts.

Section III.

DEEP DISSECTION OF THE BACK.

Directions. During the first two days that the body is placed on its face the dissector of the head and neck should be careful not to let his work interfere with that of the worker on the upper limb, whose duty it is in this time to dissect the superficial structures below the level of the seventh cervical spine, and to study and reflect the first two layers of the muscles of the back, and to examine the related structures as described in pages 1 to 10. The dissector of the abdomen also should have the opportunity of examining the arrangement of the fascia lumborum when it is displayed on the third day. Directions.

Position. The body lies with the face downwards; and the trunk is to be raised by blocks beneath the chest and the pelvis, so that the limbs may hang over the end and sides of the dissecting table. To make tense the neck, the head is to be depressed and fastened with hooks. Position of body.

In this region there are six successive layers of muscles, amongst which vessels and nerves are interspersed. The student should go over again the *surface anatomy* of the back, as described on page 2. Strata in back.

Dissection. Make an incision along the middle line of the neck from the external occipital protuberance to the spine of the seventh cervical vertebra, and reflect the skin outwards as far as the mastoid process above and as far as the outer border of the acromion below. To raise the skin.

On the *first day* the cutaneous branches of the posterior divisions of the cervical nerves should be displayed, the trapezius muscle cleaned in the neck, and the small occipital nerve traced down from the scalp in its tube of fascia along the posterior border of the sterno-mastoid muscle. Clean trapezius and nerves.

To find the nerves in the cervical region, look near the middle line, from the 3rd to the 6th vertebra, trace an offset from the third nerve upwards to the head, and follow the great occipital nerve down from the scalp to its emergence from the muscles.

Cutaneous nerves how derived.

CUTANEOUS NERVES. The tegumentary nerves of the back are derived from the posterior primary branches of the spinal nerves, which divide amongst the deep muscles into two pieces, inner and outer. Arteries accompany the greater number of the nerves, bifurcate like them, and furnish cutaneous offsets.

In the neck: source.

CERVICAL NERVES (fig. 2, p. 4). In the neck the nerves are derived from the *inner* of the two branches into which the posterior trunks divide: they perforate the trapezius, and supply the neck and the back of the head. They are four in number, and come from the second, third, fourth, and fifth nerves.

Second and third nerves.

The *branch of the second nerve* is named GREAT OCCIPITAL, and accompanies the occipital artery to the back of the head, where it has already been seen (p. 506).

The *branch of the third cervical nerve* supplies a transverse offset to the neck, and then ascends to the lower part of the head, where it is distributed near the middle line, internal to the great occipital nerve, with which it usually communicates.

The trapezius.

The position and attachments of the TRAPEZIUS in the neck should be carefully made out and the student may read the description of the muscles on pages 4 to 6.

Dissection. Divide trapezius. Clean spinal accessory nerve

Dissection. On the *second day* the trapezius and latissimus dorsi muscles are divided longitudinally and the parts thrown outwards and inwards. The trapezius is divided about two inches from the middle line, but before dividing it the student should make out the *spinal accessory nerve* in the posterior triangle of the neck as it passes downwards and outwards to the under surface of the muscle; the nerve being looked for at the posterior border of the sterno-mastoid about the junction of the upper with its middle third. Parallel with, but below, the spinal accessory, and communicating with it beneath the trapezius, will be found branches of the third and fourth cervical nerves.

The branches of the *superficial cervical artery* to the under surface of the trapezius will also be cleaned and after the reflection of the inner part of the muscle the dissector should clean the *splenius*, and the upper part of the levator anguli scapulæ, and define the things *beneath the clavicle*, viz., the posterior belly of the omo-hyoid muscle (fig. 210, p. 576) with the suprascapular nerve and vessels, as well as the transverse cervical vessels, and the small nerves to the levator anguli scapulæ and rhomboid muscles. If the trapezius be detached along the middle line, the ligamentum nuchæ, from which it takes origin, will be brought into view.

and parts in posterior triangle.

Ligamentum nuchæ.

The LIGAMENTUM NUCHÆ is a narrow fibrous band which extends from the spinous process of the seventh cervical vertebra to the external occipital protuberance. From its deep surface a thin layer of fibres, which forms a median partition between the muscles of the two sides of the neck, is sent forwards to be attached to the external occipital crest and to the other cervical spines.

Dissection. On the *third* day after the latissimus dorsi has been divided, the dissector of the head and neck is to examine the

lumbar fascia between the last rib and the hip bone, in company with the worker on the abdomen.

In the region referred to are portions of the external and internal oblique muscles in the wall of the abdomen. Define the posterior border of the external oblique (fig. 98, p. 265). Internal to this the aponeurosis of the transversalis muscle (fascia lumborum, p. 272) appears, and perforating it are two nerves: one, the last dorsal, with an artery near the last rib; and the other, the ilio-hypogastric, with its vessels close to the iliac crest. Define external oblique

Three layers of the fascia lumborum are to be demonstrated, passing from the aponeurosis of the transversalis to the spinal column. The superficial layer is already exposed, being formed mainly by the aponeurosis of the latissimus dorsi. To see the middle layer, which passes beneath the erector spinæ to the transverse processes, the first layer is to be divided, with the attached portion of the latissimus dorsi, by a horizontal incision carried outwards from the third lumbar spine. On raising the outer border of the erector spinæ muscle, which comes into view, the strong middle process of the fascia will be apparent. to show three layers in it,— posterior, middle,

After cutting in the same way through this prolongation, another muscle, the quadratus lumborum, will be seen; and, on raising its outer border, the thin deepest layer of the fascia will be evident on the abdominal aspect of that muscle. and anterior.

The FASCIA LUMBORUM or LUMBAR APONEUROSIS occupies the interval between the last rib and the iliac crest, and extends inwards to the spine. It is formed mainly by the posterior tendon of the transversalis muscle of the abdominal wall (fig. 101, c, p. 271), but its superficial part receives important accessions from two of the muscles of the back. If the tendon of the transversalis be followed inwards, it will be found to divide at the outer edge of the quadratus lumborum into two layers, which encase that muscle; and the posterior of these again splits, or gives off a superficial process, at the outer margin of the erector spinæ. There are thus in the lumbar aponeurosis three layers of membrane, forming with the vertebræ two sheaths, the one of which encloses the quadratus lumborum, and the other the multifidus and erector spinæ muscles. Lumbar fascia, derived from transversalis tendon, consists of three layers:

The *anterior layer* is thin, and passes on the abdominal surface of the quadratus lumborum to be fixed to the front of the transverse processes of the lumbar vertebræ near their tips. anterior,

The *middle layer* is the direct continuation of the transversalis tendon, and lies between the quadratus lumborum and the erector spinæ muscles; it is fixed to the extremities of the transverse processes. and middle to transverse processes;

The *posterior* or *superficial layer* is the thickest, and is attached internally to the spines of the lumbar vertebræ. In this layer are united the aponeuroses of the latissimus dorsi and serratus posticus inferior muscles, with only a small offset of the tendon of the transversalis. posterior to spinous processes.

Directions. The structures in the floor of the posterior triangle

will be only incompletely displayed at present, but the following points are to be made out (fig. 210, p. 576).

Levator anguli scapulæ.

1. The *levator anguli scapulæ* arises by four separate slips from the posterior tubercles of the transverse processes of the upper four cervical vertebræ, and in the case of the upper three slips, they will be found to be attached immediately in front of those of the splenius colli muscle.

Posterior belly of the omo-hyoid.

2. The *posterior belly of the omo-hyoid* passes from the upper border of the scapula behind the notch, and from the ligament converting the notch into a foramen, and forms a thin, riband like muscle, which is directed forwards from beneath the trapezius across the lower part of the neck, over the brachial plexus and the suprascapular nerve, to the under surface of the sterno-mastoid, where it ends in the intermediate tendon.

Supra-scapular artery: course to shoulder.

The SUPRASCAPULAR ARTERY, a branch of the subclavian, is directed outwards through the lower part of the neck to the upper border of the scapula. It runs behind the clavicle, and crosses the suprascapular ligament in front of the omo-hyoid muscle, to enter the supraspinous fossa.

Supra-scapular nerve.

The SUPRASCAPULAR NERVE is an offset of the fifth and sixth cervical nerves in the brachial plexus and inclines downwards beneath the omo-hyoid muscle to the notch in the upper border of the scapula, through which it passes into the supraspinous fossa.

Transverse cervical artery

The TRANSVERSE CERVICAL ARTERY, also a branch of the subclavian, has the same direction as the suprascapular, towards the upper angle of the scapula, but it is higher than the clavicle. Crossing the upper part of the space in which the sub-clavian

divides into

artery lies, it passes beneath the trapezius, and divides into *superficial cervical* and *posterior scapular* branches.

superficial cervical and

a. The *superficial cervical branch* is distributed chiefly to the under surface of the trapezius, though it furnishes offsets to the levator anguli scapulæ and the cervical glands.

posterior scapular.

b. The *posterior scapular branch* crosses under the levator anguli scapulæ, and descends along the base of the scapula beneath the rhomboid muscles (p. 9). This branch arises very frequently from the third part of the subclavian trunk.

Accompanying veins.

The *suprascapular* and *transverse cervical veins* have the same course and branches as the arteries above described; they open into the external jugular, near its junction with the subclavian vein.

Nerve of rhomboid muscles.

NERVE TO THE RHOMBOID MUSCLES. This slender offset of the fifth cervical nerve in the brachial plexus courses beneath the elevator of the angle of the scapula, and is distributed to the rhomboidei on their deep surface. Before its termination it supplies one or two twigs to the elevator of the scapula.

Dissection. On the third day the rhomboid muscles will have been reflected and the part will be free to the dissector of the head and neck for two days, during which time he will examine the rest of the parts described in this Section, as well as the spinal cord and the contents of the spinal canal as set forth in Section IV.

After removing the loose areolar tissue beneath the rhomboids the thin *serratus posticus superior* muscle will be laid bare. The *serratus posticus inferior* has been already displayed by the reflection of the latissimus dorsi.

The muscles of the THIRD LAYER are the two serrati muscles. They are very thin, and receive their name from their toothed attachment to the ribs. Their origin from the spines of the vertebræ is aponeurotic. Serrati are two in number.

The SERRATUS POSTICUS SUPERIOR (fig. 190, A) *arises* from the ligamentum nuchæ, and from the spinous processes of the last cervical, and upper two or three dorsal vertebræ, with the supraspinous ligament. The fleshy fibres are inclined downwards and outwards, and are *inserted* by slips into four ribs, from the second to the fifth, external to their angles. The upper the smaller; attachments;

The muscle rests on the splenius, and is covered by the rhomboidei, except at its upper border. relations.

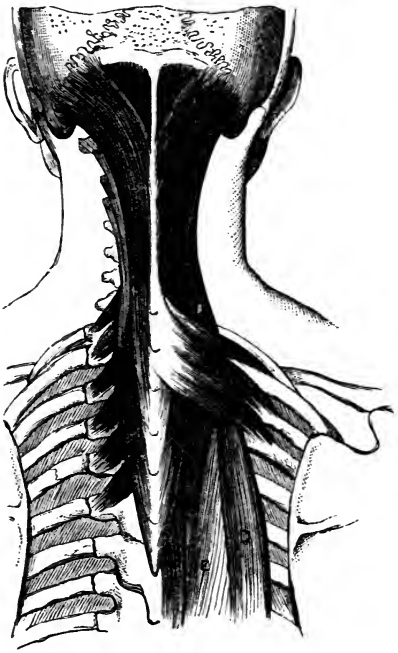


Fig. 190.—Part of the Third and Fourth Layers of the Muscles of the Back.

A. Serratus posticus superior.
B. Splenius capitis.
C. Splenius colli.
D. Continuation of the ilio-costalis.
E. Longissimus dorsi.
F. Spinalis dorsi.

The SERRATUS POSTICUS INFERIOR (fig. 3, G, p. 5) is wider than the preceding muscle. Its aponeurosis of *origin* is inseparably united with that of the latissimus dorsi, and with the fascia lumborum, and is connected to the spinous processes of the last two dorsal and upper two or three lumbar vertebræ. The fleshy fibres ascend somewhat to be *inserted* into the last four ribs outside their angles, each successive piece extending further forwards than the one below. Inferior serratus: origin; insertion;

This muscle lies on the mass of the erector spinæ; and with the upper border of its tendon the vertebral aponeurosis is united. relations.

Action. Both serrati are inspiratory muscles. The upper one raises the ribs into which it is inserted; while the lower one draws Use of serrati.

backwards the lower ribs, and prevents their being carried upwards by the contraction of the diaphragm.

Vertebral aponeurosis: The VERTEBRAL APONEUROSIS is a thin fascia which covers the fourth layer of muscles in the thoracic region. Internally it is attached to the spinous processes of the vertebræ. Externally it is

attachments; fixed to the angles of the ribs; and in the intervals between the bones it joins the layer of connective tissue covering the intercostal

continuation below, and above. muscles. It is continuous below with the tendon of the serratus posticus inferior, and through this with the superficial layer of the fascia lumborum; but above, it passes beneath the upper serratus, and blends with the deep intermuscular fascia of the neck. The strongest fibres of the membrane are directed transversely.

Muscles of fourth layer. FOURTH LAYER OF MUSCLES. This comprises the splenius muscle and the erector spinæ, with its divisions and accessory muscles to the neck.

Dissection. **Dissection.** The upper serratus is to be cut through, the vertebral aponeurosis taken away, and the part of the splenius muscle under the serratus cleaned. In turning outwards the fleshy part of the serratus, slender twigs of the intercostal nerves, which perforate the external intercostal muscle accompanied by small arteries, may be found entering its slips.

Splenius has two parts: The SPLENIUS MUSCLE (fig. 190) is flat and elongated. Single at its origin, it is divided into two parts, one passing to the head—splenius capitis, and the other to the neck—splenius colli. It *arises* from the upper six dorsal and the seventh cervical spines, and from the ligamentum nuchæ as high as the third cervical vertebra. The fibres are directed upwards and outwards to their insertion.

one to the neck; The *splenius colli* (C marked low down on the left side of the figure) is *inserted* by tendinous slips into the posterior tubercles of the transverse processes of the upper two or three cervical vertebræ with, but behind, the attachment of the elevator of the angle of the scapula.

the other to the head; The *splenius capitis* (B), much the larger, is *inserted* into the apex and hinder border of the mastoid process, and into the outer third of the superior curved line of the occipital bone.

relations. The muscle is situate beneath the trapezius, the rhomboidei, and the serratus superior; and the insertion into the skull is beneath the sterno-mastoid. The complexus muscle appears above the upper border of the splenius capitis. The splenius represents the prolongation to the upper cervical vertebræ and head of the outer portion of the erector spinæ.

Use of splenius capitis, *Action.* The cranial parts of the muscles of the two sides will carry the head directly back; and one will incline and rotate the head to the same side.

splenius colli. The splenius colli of both sides will bend back the upper cervical vertebræ; but one muscle will turn the face to the same side, being able to rotate the head by its attachment to the transverse process of the atlas.

Divide splenius, and seek nerves. **Dissection** (fig. 191, p. 527). The splenius is to be detached from the spinous processes, and thrown outwards. In doing this,

small branches from the external divisions of the posterior cervical nerves to the pieces of the muscle are to be looked for.

As the ERECTOR SPINÆ is displayed in the dorsal and lumbar regions, two prolongations from it to the cervical vertebræ and the head are to be defined :—One, a thin narrow muscle, the *cervicalis ascendens*, is continued beyond the ribs from the outer piece of the erector (*ilio-costalis*), and is to be separated from the muscles around. The other is a larger offset of the inner piece (*longissimus dorsi*) of the erector muscle ; single at first where it is united with the fibres of the longissimus, it is divided afterwards, like the splenius, into a cranial part (*trachelo-mastoid*) and a cervical part (*transversalis colli*). Define offsets from the erector spinæ.

The serratus inferior is to be detached from the spines and thrown outwards, when fine nerves will be found entering it like those to the upper muscle. The superficial layer of the fascia lumborum is also to be removed, and the areolar tissue is to be cleaned from the surface of the large mass of the erector spinæ which now comes into view. Opposite the last rib is an intermuscular interval, which divides the erector spinæ into an outer piece (ilio-costalis), and an inner (longissimus dorsi). By sinking the knife into this interval the ilio-costalis may be turned outwards, and the longitudinal column of muscle forming the *outer part of the erector spinæ* will be defined. Show the erector spinæ and its divisions. Ilio-costalis.

Its parts are named, from below upwards—

1. The Ilio-costalis.
2. The Musculus accessorius.
3. The Cervicalis ascendens.

The ilio-costalis is a thick mass below, passing on to the lower ribs, and as it is turned outwards the fleshy slips of the accessorius will be uncovered, as they are attached to the angles of the ribs, and from this part its prolongation into the neck as the cervicalis ascendens can be readily made out. In preparing the ilio-costalis muscle, the external branches of the dorsal nerves with their accompanying arteries will appear. Vessels and nerves.

The attachments of the longissimus dorsi and its prolongation upwards as the *inner longitudinal column of the erector spinæ* are then to be traced out. Longissimus dorsi :

The parts of this column are named, from below upwards—

1. The Longissimus dorsi.
2. The Transversalis colli.
3. The Trachelo-mastoid.

Externally the longissimus has thin muscular slips of insertion into about the lower nine ribs, and thicker processes passing to the transverse processes of the lumbar vertebræ ; the latter may be shown by raising the outer border of the muscle, and clearing away the fat between it and the middle layer of the fascia lumborum. Internally the longissimus is inserted into the transverse processes of the dorsal, and the accessory processes of the lumbar vertebræ by rounded tendons ; and to see these it will be necessary to detach a thin tendinous and muscular portion of the erector mass (*spinalis* outer and inner insertions ; spinalis dorsi ;

dorsi) from the inner side of the longissimus, and to divide longitudinally the part of the thick aponeurosis springing from the lumbar spines, so as to separate the erector from the subjacent multifidus spinæ. From the longissimus, as from the ilio-costalis, a fleshy piece (transversalis colli and trachelo-mastoid) is continued into the neck.

offsets to the neck.

Vessels and nerves.

Between the longissimus and the multifidus spinæ are the internal branches of the posterior divisions of the dorsal and lumbar nerves, with offsets of the intercostal and lumbar vessels.

Erector spinæ is single below,

divided above;

superficial tendon;

origin.

ERECTOR SPINÆ. This is the muscular mass on the side of the spine, extending from the lower part of the sacrum to the head. It is single and pointed below, attains its greatest size in the loins, and over the thorax becomes divided into secondary portions to which the special names are given. Its prolongations to the neck and head are very slender. On its posterior surface, in the lumbar and sacral regions, is a strong flat tendon of origin, from which most of the fleshy fibres spring. The muscle *arises* internally from the lower two or three dorsal, and all the lumbar and sacral spines; externally from the posterior fifth of the iliac crest at the inner aspect; and inferiorly from the lower part of the back of the sacrum. Below the last rib it divides into the ilio-costalis and longissimus dorsi; and in the thoracic region the spinalis dorsi is given off from the inner side of the latter part.

Ilio-costalis:

insertion.

The ILIO-COSTALIS or SACRO-LUMBALIS is derived from the outer and superficial part of the common mass of the erector in the loins. Its fibres end in six or seven tendons, which are *inserted* into the angles of as many of the lower ribs. It is continued to the upper ribs and the neck by the two following muscles—

Accessorius:

origin;

insertion.

The ACCESSORIUS (musculus accessorius ad ilio-costalem; fig. 190, D) *arises* by a series of tendinous and fleshy slips from the angles of the lower six ribs internal to the insertion of the ilio-costalis; and it ends in tendons which are *inserted* into the remaining ribs in a line with the ilio-costalis, and into the transverse process of the seventh cervical vertebra.

Cervicalis ascendens:

origin;

insertion.

The CERVICALIS ASCENDENS is a muscular slip prolonging the accessorius into the neck; it *arises* from four ribs, viz., the sixth, fifth, fourth, and third, and is *inserted* into the posterior tubercles of the sixth, fifth, and fourth cervical vertebræ.

Longissimus dorsi:

double insertion;

The LONGISSIMUS DORSI is the largest of the pieces resulting from the division of the erector spinæ, and has two sets of insertions into the vertebræ and ribs. *Internally* it gives off a series of fleshy and tendinous bundles to the accessory processes of the lumbar vertebræ, and the transverse processes of all the dorsal vertebræ: *externally* it is attached by thick fleshy slips to the transverse processes of the lumbar vertebræ, and the middle layer of the fascia lumborum, and by thin flattened processes to the ribs, except the first two or three, between the tuberosity and angle. Its muscular prolongation to the neck is united with the upper fleshy fibres, and splits into the two following pieces:—

is continued to neck by

transversalis colli,

The TRANSVERSALIS COLLI (fig. 191, B) *arises* from the transverse

processes of the upper dorsal vertebræ (from four to six), and is *inserted* into the posterior tubercles of the transverse processes of the cervical vertebræ except the first and the last.

The TRACHELO-MASTOID MUSCLE (transversalis capitis ; fig. 191, C) *arises* in common with the preceding, and receives additional slips from the articular processes of the lower three or four cervical vertebræ. It is *inserted* beneath the splenius capitis into the posterior margin of the mastoid process, where it is about three quarters of an inch wide. and to head by trachelo-mastoid.

FIG. 191.—DISSECTION OF THE MUSCLES BENEATH THE SPLENIUS.

A. Longissimus dorsi.
B. Transversalis colli.
C. Trachelo-mastoid.
D. Complexus.
F. Splenius capitis, cut.
G. Splenius colli, cut.
H. Semispinalis dorsi.
a. Occipital artery.
1. Great occipital nerve.
2. External branch of the second nerve.
3. Outer branch of the third nerve.

The SPINALIS DORSI is a special innermost part of the erector spinæ ; it is very narrow, and springs from the tendinous slips of the erector which arise from the lower dorsal and upper two or three lumbar spines. Its fibres are *inserted* into a variable number (from four to nine) of the upper dorsal spines. Spinalis dorsi: insertion

Relations of erector in lumbar and dorsal regions;

Relations of the erector spinæ. The erector spinæ is concealed by the muscles of the layers already examined. It lies over the semispinalis and multifidus spinæ muscles, portions of the ribs and external intercostal muscles, and the levatores costarum. In the loins it is contained in the aponeurotic sheath of the fascia lumborum, and in the thoracic region a similar sheath is formed for the muscle by the vertebral aponeurosis with the ribs and dorsal vertebræ. The tendon of origin is united over the sacrum with the posterior layer of the fascia lumborum; and from its outer border in this part some fibres of the gluteus maximus arise.

and in neck.

The prolongations of the muscle in the neck lie between the splenius and levator anguli scapulæ on the outer side and the complexus on the inner side, the trachelo-mastoid being next to the complexus. The cervicalis ascendens is attached to the transverse processes in a line with the splenius colli, and immediately behind the middle and posterior scalene muscles.

Use of both erectors,

Action of erector spinæ. These powerful muscles draw backwards or extend the spine, and come into play in bringing the column into, and in maintaining the erect position. The parts inserted into the dorsal vertebræ will be to some extent inspiratory muscles, since the dilatation of the thorax is aided by extension of the vertebral column; but the slips inserted into the ribs will draw downwards these bones, and may thus act in forced expiration. The

of one muscle, and of portions in neck.

muscle of one side acting alone will incline the spine laterally. The cervical prolongations have a similar action upon the neck and head.

Muscles of fifth layer.

FIFTH LAYER OF MUSCLES. In this layer are included the complexus, the semispinalis, and the multifidus spinæ; and most of the vessels and nerves of the back are to be learnt with this layer of muscles.

Dissection of complexus,

Dissection. To display the complexus (fig. 191) it will only be necessary to turn outwards the cervical prolongations of the erector spinæ muscle, and follow down the slips of origin to the dorsal transverse processes. The semispinalis and multifidus are now partly seen below the complexus, lying between the erector spinæ and the spines of the vertebræ.

Complexus:

The COMPLEXUS (fig. 191, D) is internal to the prolongations from the longissimus dorsi, and converges towards its fellow of the opposite side at the occipital bone. Narrow at its lower end, the

origin;

muscle *arises* by tendinous slips from the transverse processes of the upper six dorsal and seventh cervical vertebræ, and from the articular processes of the succeeding cervical vertebræ as high as the third: it is also joined in most cases by one or two slips from the lowest cervical or upper dorsal spines. The fleshy fibres pass

insertion;

upwards to be *inserted* into an impression between the curved lines of the occipital bone, which reaches outwards nearly two inches from the external occipital crest.

tendinous intersections;

The inner part of the complexus, having two fleshy bellies with an intervening tendon, is often described separately as the *biventer cervicis*. Another tendinous intersection crosses the cutaneous surface of the muscle near the upper end.

The complexus is concealed by the splenius and trapezius. Along the inner side is the semispinalis muscle, with the ligamentum nuchæ. Beneath it are the small recti and obliqui muscles, the semispinalis, and the posterior cervical nerves and vessels; and the cutaneous offsets of two or three of the nerves perforate it. relations;

The complexus may be regarded as the cranial prolongation of the semispinalis muscle. use.

Action. Both muscles will move the head directly backwards. One will draw the occiput down and backwards towards its own side. Dissection of the nerves of the neck;

Dissection *of vessels and nerves* (fig. 192, p. 531). In the neck the nerves and vessels will be brought into view by detaching the complexus from the occipital bone and the spines of the vertebræ, and carefully raising it from the subjacent parts. Beneath the muscle are the ramifications of the cervical nerves, and the deep cervical and other vessels, surrounded by dense connective tissue.

Each nerve, except the first, divides into an inner and an outer branch. Dissect out first the inner branches, which lie partly over and partly beneath the fibres of the semispinalis muscle (fig. 192, G). The external branches are very small, and are given off between the transverse processes close to where the trunks appear; they are to be looked for outside the complexus, entering the muscles prolonged from the erector spinæ and the splenius. inner and outer branches;

The small first nerve is the most difficult of the set to find: it is a short trunk, contained in the interval between the recti and obliqui muscles near the head, and will be best found by looking for the small twigs furnished by it to the muscles around. first nerve

The *deep cervical artery* is met with on the semispinalis muscle; a part of the vertebral artery will be found in contact with the first nerve; and the occipital artery will be visible crossing the occipital bone. and the vessels:

Opposite the thorax the *dorsal nerves and vessels* will be readily displayed on the inner side of the longissimus dorsi muscle, on the removal of a little fatty tissue from between the transverse processes. External and internal branches are to be traced from each nerve and vessel into the muscles: some of the former have been seen in the interval between the ilio-costalis and the longissimus dorsi. nerves and vessels in the dorsal region;

The two branches of the *lumbar nerves and vessels* are in the same line as the dorsal; but the inner set are difficult to find. in the lumbar region.

The sacral nerves are placed beneath the multifidus spinæ, and will be dissected after the examination of that muscle.

Posterior Primary Branches of the Spinal Nerves. The spinal nerves, with a few exceptions in the cervical and sacral groups, divide in the intervertebral foramina into their anterior and posterior primary branches. The posterior supply the integuments and the muscles of the back, and are now to be learnt. Posterior branches of spinal nerves.

In the neck. The posterior primary divisions of the cervical nerves are eight in number, and issue between the transverse processes; but those of the first and second, which begin on the neural In the neck

they divide into two except first.

arches of the atlas and axis, appear above those arches. All, except the first, divide into internal and external branches.

External branches are small.

The *external branches* are very small, and end in the splenius, and in the muscles prolonged from the erector spinæ.

Internal branches:

The *internal branches* (fig. 192) are larger than the external; they are directed towards the spinous processes, the lower three passing beneath the semispinalis, and the upper four over that

some give cutaneous offsets.

muscle. By the side of the spines cutaneous branches are furnished to the neck and the head from the nerves that are superficial to the semispinalis: these *cutaneous offsets* ascend to the surface through the splenius, the complexus, and the trapezius muscles, and are distributed as already seen (p. 520). In their course the nerves supply the surrounding muscles, viz., complexus, semispinalis, multifidus spinæ, and interspinales.

The cutaneous branches of the second and third nerves reach the head, and require a separate notice.

Second ascends to head.

That of the *second nerve* (fig. 192,2) named *great occipital*, appears beneath the inferior oblique muscle, to which it gives offsets, and is directed upwards through the complexus and trapezius to end over the occiput (p. 506).

Third supplies neck and head,

The branch of the *third nerve* (fig. 192,3), becoming superficial near the middle line, gives an offset upwards to the lower part of the occiput, internal to the preceding. This nerve usually joins the great occipital twice, viz., beneath the complexus and superficial to the trapezius.

First nerve

The *posterior primary division of the suboccipital* or *first spinal nerve* (fig. 192,1) is very short, and appears in the interval between the recti and obliqui muscles. In passing from the spinal canal it is placed between the posterior arch of the atlas and the vertebral artery.

ends in muscles.

From its extremity branches radiate to the surrounding muscles, viz., one to the upper part of the complexus, another to the rectus posticus major and minor, and two short branches to the obliquus superior and inferior: the offset to the last muscle joins the inner branch of the second cervical nerve. Occasionally the first nerve gives a cutaneous branch to the occiput.

Dorsal nerves.

In the dorsal region. The posterior primary divisions of the dorsal nerves, twelve in number, appear between the transverse processes, and bifurcate into internal and external branches.

Outer branches to erector spinæ:

The *external branches* increase in size from above downwards, and pass beneath the longissimus dorsi to the interval between that muscle and the ilio-costalis, distributing offsets to the several divisions of the erector spinæ. The branches of the *upper six* or *seven* nerves end in these muscles; but the *lower five* or *six*, after

lower ones become cutaneous.

reaching the interval between the longissimus and ilio-costalis, are continued to the surface through the serratus and latissimus muscles, nearly in a line with the angles of the ribs.

Inner branches to transverso-spinales:

The *internal branches* are larger above than below, and supply the transverso-spinales muscles. The *upper six* or *seven* are directed inwards between the semispinalis and multifidus spinæ, and become

upper ones reach surface.

cutaneous by the side of the spinous processes, after perforating the

splenius, serratus superior, rhomboideus, and trapezius muscles. The *lower five* or *six* are much smaller, and end in the multifidus spinæ.

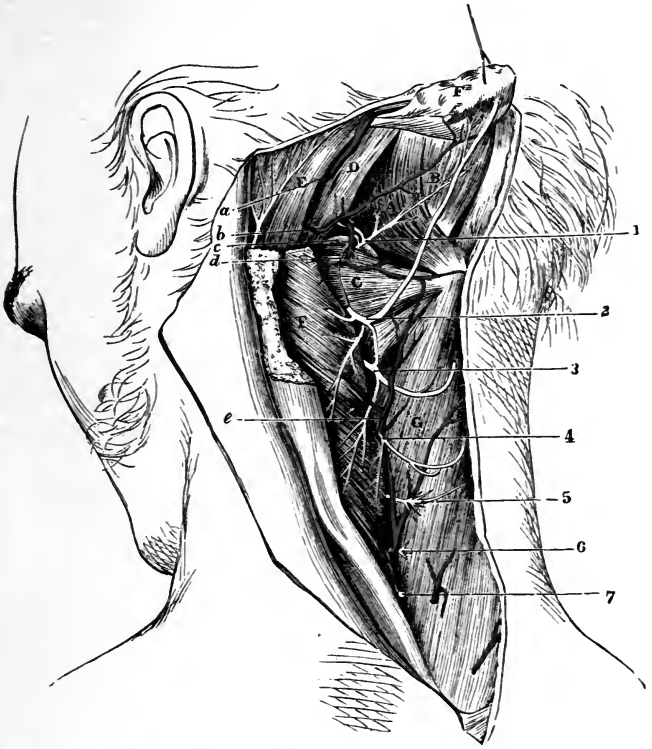


FIG. 192.—DEEP DISSECTION OF THE BACK OF THE NECK (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Rectus posticus major.
B. Rectus posticus minor.
C. Obliquus inferior.
D. Obliquus superior.
E. Sterno-mastoid.
F. Complexus, cut across.
G. Semispinalis colli.

Arteries:

a. Occipital, and *b*, its princeps cevicis branch.
c. Vertebral artery, and *d*, its cervical branch.
e. Deep cervical.

Nerves:

1. Posterior branch of the sub-occipital.
2 to 7. Inner branches of the posterior primary divisions of the respective cervical nerves.

IN THE LOINS. The posterior primary branches of the lumbar nerves, five in number, appear between the erector and multifidus spinæ. In their mode of dividing and general arrangement they resemble the lower dorsal nerves, cutaneous offsets being furnished by the external set of branches. Lumbar nerves are divided into two.

External branches :

The *external branches* pass to the erector spinæ, and supply it and the intertransverse muscles. The first three pierce the erector spinæ, and become cutaneous after perforating the posterior layer of the fascia lumborum. The branch of the last nerve is connected with the corresponding part of the first sacral nerve by an offset near the bone.

first three become cutaneous.

Internal branches,

The *internal branches* are furnished to the multifidus spinæ muscle. They are difficult to find, being contained in grooves on the upper articular processes.

Vessels.

VESSELS IN THE BACK. The vessels now dissected are the *occipital* and the *deep cervical arteries*, a small part of the *vertebral* and the posterior branches of the *intercostal* and *lumbar* arteries of the aorta. Veins accompany the arteries.

Part of the occipital artery,

The OCCIPITAL ARTERY (fig. 192, *a*) courses along the occipital bone. Appearing from beneath the digastric muscle, the vessel is directed backwards under the sterno-mastoid, the splenius, and, usually, the trachelo-mastoid, but over the obliquus superior and complexus muscles. Behind the insertion of the sterno-mastoid it becomes superficial, and ascends to the occiput, where it is distributed (p. 503). It supplies the surrounding muscles, and gives the following branch to the neck :—

which gives a

cervical branch.

The *princeps cervicis* (fig. 192, *b*) artery from the occipital distributes twigs to the splenius and trapezius, and passing beneath the complexus, anastomoses with the vertebral and deep cervical arteries.

Part of the vertebral artery.

The VERTEBRAL ARTERY (fig. 192, *c*) lies on the neural arch of the atlas, behind the articulating process, and appears in the interval between the straight and oblique muscles. Beneath it is the suboccipital nerve. Small branches are given to the surrounding muscles, and to anastomose with the contiguous arteries.

Deep cervical artery.

The DEEP CERVICAL ARTERY (fig. 192, *e*) arises in common with the superior intercostal artery from the subclavian. Passing backwards between the transverse process of the last cervical vertebra and the neck of the first rib, it ascends between the complexus and semispinalis muscles, as high as the upper border of the latter, and anastomoses with the cervical branch of the occipital artery. The contiguous muscles receive branches from it, and anastomoses are formed between its offsets and those of the vertebral.

Dorsal arteries are split into

The POSTERIOR BRANCHES OF THE INTERCOSTAL ARTERIES pass back between the vertebræ and the superior costo-transverse ligament, and divide like the nerves into inner and outer pieces.

inner and

The *internal branches* end in the fleshy mass of the multifidus spinæ and semispinalis, and furnish small cutaneous offsets with the nerves.

outer branches,

The *external branches* cross beneath the longissimus dorsi, and supply it and the ilio-costalis. Like the nerves, the lowest branches of this set are the largest, and extend to the surface.

and give a spinal branch.

As the dorsal branch of the intercostal artery passes by the intervertebral foramen, it furnishes a small *intraspinal artery* to the spinal canal.

The POSTERIOR BRANCHES OF THE LUMBAR ARTERIES divide, like the foregoing, into internal and external pieces, as soon as they reach the interval between the erector and multifidus spine. Each gives also a *spinal branch* to the spinal canal. Lumbar arteries divide also into

The *internal branches* are small, and end in the multifidus spinæ: inner and

The *external branches* supply the erector spinæ; and offsets are continued to the integuments with the superficial nerves. outer branches.

VEINS. The *occipital veins* communicate usually with the lateral sinus of the skull through the mastoid foramen, and pass beneath the complexus to enter the deep cervical vein. Occipital veins.

The *deep cervical vein* is of large size, and besides receiving the occipital veins, communicates with the other deep veins of this region, forming the posterior plexus of the neck. It passes forwards with its artery between the transverse processes, and joins the vertebral vein. Deep cervical vein, and plexus of back of neck.

The *vertebral vein* begins above the neural arch of the atlas by the union of an offset leaving the spinal canal with the artery and branches from the above-mentioned plexus. Beginning of the vertebral vein.

The *dorsal* and *lumbar veins* agree in their branching and distribution with the arteries they accompany, and end in the corresponding trunks of the thoracic and abdominal wall. Dorsal and lumbar,

In contact with the spinous processes and laminæ of the vertebræ is a deeper set of veins (*dorsal spinal*), which anastomose freely together, and communicate through the ligamenta subflava with the veins in the interior of the spinal canal. and deep veins,

TRANSVERSO-SPINALES. Occupying the vertebral groove by the side of the spinous processes is a long muscular mass, which extends from the lower part of the sacrum to the axis. This is composed of slips which are directed obliquely from transverse or articular processes to spinous processes, and are therefore designated collectively transverso-spinales. The slips differ in length, and form three layers, which are described as separate muscles, viz., a superficial stratum of long slips, confined to the cervical and dorsal regions—the *semispinalis;* a middle portion, with slips of intermediate length—the *multifidus spinæ;* and a deep set of very short fasciculi, present only in the thoracic region—the *rotatores dorsi.* The semispinalis and multifidus are only to be separated with difficulty; but the rotatores are more distinct, and are included in the next layer. Transverso-spinales: arrangement, and subdivisions.

The SEMISPINALIS consists of slips which pass over four or five vertebræ, and it is subdivided into the following two parts, but the separation between them is not always distinct. Semispinalis is divided into

The *semispinalis dorsi* is thinner than the upper part; it *arises* from the transverse processes of the dorsal vertebræ from the sixth to the tenth, and is *inserted* into the spines of the last two cervical and the upper four dorsal vertebræ. semispinalis dorsi

The *semispinalis colli* (fig. 192, G) *arises* from the transverse processes of the upper six dorsal vertebræ, and is *inserted* into the spines of the cervical vertebræ above the last, except into the atlas, The insertion into the massive spine of the axis is much the largest. and semispinalis colli.

Dissection of multifidus spinæ.

Dissection. The multifidus spinæ is now to be prepared. The upper part of it will be exposed by cutting through the insertion of the semispinalis, and turning aside that muscle.

Over the sacrum the thick aponeurosis of the erector spinæ must be removed. In the dorsal region the multifidus spinæ will appear on detaching and reflecting the semispinalis from the spines. The slips by which the muscle is attached to the processes of the vertebræ should be defined and separated.

Origin of multifidus spinæ from pelvis, from lumbar, dorsal, and cervical vertebræ; insertion into spines.

The MULTIFIDUS SPINÆ reaches from the sacrum to the axis: it is larger below than above, and is smallest in the upper dorsal region. It takes *origin at the pelvis* from the back of the sacrum between the spines and the external row of processes as low as the fourth aperture, from the posterior sacro-iliac ligament, from the inner side of the posterior superior spine of the ilium, and from the overlying tendon of the erector spinæ; *in the loins* it arises by large fasciculi from the mamillary processes of the vertebræ; *in the dorsal region* by thinner slips from the transverse processes; and *in the neck* from the articular processes of the lower four cervical vertebræ. From these attachments the fibres are directed obliquely upwards and inwards, passing over from one to three vertebræ, to be *inserted* into the spinous processes from the axis to the last lumbar vertebra.

Relations of transverso-spinales; and use.

The transverso-spinales are entirely concealed by the erector spinæ and complexus muscles; and beneath them are the laminæ of the vertebræ, with the dorsal spinal plexus of veins. Internally they rest against the spinous processes and the interspinal muscles.

Action. The transverso-spinales of the two sides acting together will extend the spine: and the muscles of one side can rotate the column in the cervical and dorsal regions, turning the face in the opposite direction.

Muscles of the sixth layer.

SIXTH LAYER OF MUSCLES. This layer includes a number of short muscles which pass between adjacent vertebræ, or from the first two vertebræ to the head. They are:—

1. The rectus capitis posticus major.
2. The rectus capitis posticus minor.
3. The obliquus capitis superior.
4. The obliquus capitis inferior.
5. The rotatores dorsi.
6. The interspinales.
7. The intertransversalis.

Dissection of suboccipital muscles, and other muscles of last layer.

Dissection. Between the first two cervical vertebræ and the occipital bone are the recti and oblique muscles, which are to be fully cleaned.

The slips of the multifidus spinæ are to be detached from the spines of the vertebræ and turned downwards in order to show the rotatores dorsi in the thoracic region, and the interspinal muscles in the neck and loins. The intertransverse muscles of the lumbar region will be exposed by removing the erector spinæ.

Rectus posticus major:

The RECTUS CAPITIS POSTICUS MAJOR (fig. 192, A) *arises* from the side of the spinous process of the axis, and is *inserted* into the

outer part of the inferior curved line of the occipital bone for about an inch, as well as into the surface below it. attachments;

The muscle is covered by the complexus, and, at its insertion, by the obliquus superior. It lies over the posterior arch of the atlas and the ligaments attached to that part of the bone, relations;

Action. By the action of both muscles the head will be drawn backwards. One rectus acting alone will rotate, as well as extend the head, turning the face to the same side. and use.

The RECTUS CAPITIS POSTICUS MINOR (fig. 192, B) is a small fan-shaped muscle, lying to the inner side of the preceding. *Arising* close to the middle line from a slight roughness on the posterior arch of the atlas, it is *inserted* into the inner third of the inferior curved line of the occipital bone and an impression below this. Rectus posticus minor: attachments;

This muscle is deeper than the rectus major, and lies over the posterior occipito-atlantal ligament. The two small recti correspond to the interspinal muscles between the other vertebræ. relations;

Action. The rectus posticus minor extends the head. and use.

The OBLIQUUS CAPITIS INFERIOR (fig. 192, C) is the strongest of the suboccipital muscles. It *arises* from the spinous process of the axis below the rectus posticus major, and is *inserted* into the lower and back part of the transverse process of the atlas. Obliquus inferior: attachments;

The inferior oblique is concealed by the complexus and trachelo-mastoid muscles, and is crossed by the great occipital nerve. relations;

Action. This muscle turns the face to the same side, by rotating the atlas on the axis. and use.

The OBLIQUUS CAPITIS SUPERIOR (fig. 192, D) *arises* from the transverse process of the atlas above the insertion of the preceding muscle, and is directed upwards and inwards to be *inserted* into the outer part of the space between the curved lines of the occipital bone. Obliquus superior: attachments;

The origin of the muscle is beneath the trachelo-mastoid, and its insertion beneath the complexus. In the interval between these it is covered by the splenius. It lies over the vertebral artery and the insertion of the rectus posticus major. relations

Action. With its fellow the upper oblique will assist in carrying backwards the head. By the action of one muscle the head will be inclined backwards, and to the same side. and use.

SUBOCCIPITAL TRIANGLE. This name is given to the small space which is bounded below by the obliquus inferior muscle, by the rectus posticus major on the inner side and above, and by the obliquus superior on the outer side. It is covered by the complexus; and its floor is formed by the neural arch of the atlas, with the posterior occipito-atlantal ligament. In it are seen a small part of the vertebral artery, and the posterior branch of the suboccipital nerve issuing below the artery and lying upon the posterior arch of the atlas. Triangular space between the muscles: contents.

The contents of the sub-occipital traingle should be fully displayed before the following parts are studied.

The ROTATORES DORSI are eleven short muscular slips in the dorsal region beneath the multifidus spinæ, from which they Rotatores dorsi:

attachments. are separated by fine areolar tissue. Each *arises* from the upper and back part of a transverse process, and is *inserted* into the lower border of the neural arch of the vertebra next above. The first springs from the transverse process of the second vertebra.

Interspinal muscles: The INTERSPINALES are arranged in pairs in the intervals between the spinous processes. They are most developed in the neck and loins.

in neck; In the *cervical region* they are small rounded bundles attached to the bifurcated extremities of the spines from the axis downwards.

in dorsal region: In the *dorsal region* interspinal muscles are only present in one or two of the highest and lowest spaces.

in loins; In the *lumbar region* they are thin flat muscles, reaching the whole length of the spine, one on each side of the interspinous ligament.

their use. *Action.* The muscles help to extend the spine.

Intertransverse muscles: The INTERTRANSVERSALES lie between the transverse processes of the vertebræ; but only those in the loins and the back are now dissected.

in neck; In the *neck* they are double, and resemble the interspinal muscles of the cervical vertebræ.

in dorsal region; In the *dorsal region* they are single rounded bundles of small size, and are found only between the four or five lower vertebræ. They are represented in the middle spaces by thin fibrous bands. which constitute the so-called intertransverse ligaments.

in loins; In the *lumbar region* there are two muscles in each space. The outer set are thin flat muscles between the transverse processes. The inner muscles are rounded bundles in a line with those of the dorsal region; they are attached to the accessory processes above, and the mamillary processes below; and the highest is between the last dorsal and the first lumbar vertebræ.

their use. *Action.* The intertransverse muscles assist in bending the spine laterally.

Dissection of sacral nerves. **Dissection** (fig. 193, p. 537). To see the posterior divisions of *the sacral nerves*, it will be necessary to remove the part of the multifidus spinæ covering the sacrum. The upper three nerves are each split into two; their external branches will be found readily on the great sacro-sciatic ligament, from which they may be traced inwards; the inner branches are very slender and difficult to find.

The lower two nerves are very small, and do not divide like the others. They are to be sought on the back of the sacrum, below the attachment of the multifidus spinæ. The fourth comes through a sacral aperture, and the fifth between the sacrum and coccyx. The coccygeal nerve is still lower, by the side of the coccyx.

Five sacral nerves. SACRAL NERVES (fig. 193). The posterior primary branches of the sacral nerves are five in number. Four issue from the spinal canal by the apertures in the back of the sacrum, and the fifth between the sacrum and the coccyx. The first three have the

common branching into inner and outer pieces, like the other spinal nerves; but the last two are undivided.

The *first three nerves* (1 s, 2 s and 3 s) are covered by the multifidus spinæ, and divide regularly.

The *inner pieces* (1) are distributed to the multifidus; the last of this set is very fine.

The *outer pieces* (2) are larger, and have communicating offsets from one to another on the back of the sacrum; the branch of the first is also connected with the corresponding part of the last lumbar nerve; and the branch of the third joins in a similar way the sacral nerve next below. After this looping they pass outwards to the surface of the great sacro-sciatic ligament, where they join a second time, and become cutaneous.

Last two nerves (4 s and 5 s). These nerves, which are below the multifidus, are much smaller than the preceding, and want the regular branching of the others: they are connected with each other and the coccygeal nerve by loops on the back of the sacrum. A few filaments are distributed over the back of the coccyx.

Coccygeal nerve (1 c). Its posterior primary branch issues through the lower aperture of the spinal canal, and appears by the side of the coccyx. It is joined in a loop with the last sacral nerve, and ends on the posterior surface of the coccyx.

Sacral arteries. Small branches of the lateral sacral arteries leave the spinal canal with the sacral nerves; they supply the multifidus spinæ, and anastomose on the back of the sacrum with offsets from the gluteal and sciatic arteries

First three have inner and outer branches; latter give cutaneous offsets.

Last two are undivided.

Fig. 193.—Dissection of the Posterior Divisions of the Sacral Nerves.

Muscles:

A. Multifidus spinæ, and B. Erector spinæ: both cut.

C. Gluteus maximus detached from its origin, and thrown down.

D. Great sacro-sciatic ligament.

Nerves:

5*l*. Last lumbar.

1 s to 5 s. The five sacral nerves issuing from the sacrum.

Coccygeal nerve.

1 c. The coccygeal nerve escaping by the opening of the sacral canal.

1. Internal offsets of the last lumbar and first three sacral (these are represented too large).

2. External offsets of the same nerves.

3. Anterior, and 4, posterior primary branch of the coccygeal nerve.

Small sacral arteries.

5. The nerve derived from the anterior divisions of the last two sacral and the coccygeal nerves, piercing the great sacro-sciatic ligament and the gluteus maximus muscle.

Dissection of costal muscles.

Dissection. The posterior part of the wall of the thorax may be examined before the body is again turned. By removing opposite the ribs, the ilio-costalis and longissimus dorsi, the small levatores costarum will be uncovered. The hinder part of the external intercostal muscles will be denuded at the same time.

Levatores costarum:

The LEVATORES COSTARUM are twelve small fan-shaped muscles, which are connected with the hinder parts of the ribs. Each, except the first, *arises* from the tip of the transverse process of a

attachments.

dorsal vertebra, and is *inserted*, the fibres spreading out, into the upper border of the rib beneath, from the tuberosity to the angle. The muscles increase in size from above down, and their fibres have the same direction as the external intercostal layer.

The first.

The first is fixed above to the transverse process of the last cervical

Longer elevator muscles.

vertebra, and below to the outer border of the first rib. Some of the fibres of the lower muscles are continued beyond one rib to that next succeeding: these longer slips have been named *levatores longiores costarum.*

Use.

Action. These muscles have but little influence in elevating the ribs; and their principal use appears to be in extending and bending laterally the spine.

Outer intercostal muscle.

The EXTERNAL INTERCOSTAL MUSCLE is continued backwards along the ribs as far as the tuberosity, where it joins the elevator muscle. Beneath the muscle are the intercostal nerve and artery.

Dissection.

Dissection. To trace the anterior and posterior primary branches of the dorsal nerves to their common trunk, the elevator of the rib and the external intercostal muscle are to be cut through in one or more spaces. The intercostal artery with its posterior branch is laid bare by this proceeding.

Dorsal nerve has

The DORSAL NERVES split in the intervertebral foramina into anterior and posterior primary branches.

posterior

The *posterior branches* are directed backwards, internal to the superior costo-transverse ligament; and their distribution has been seen in the foregoing dissection.

and anterior branches.

The *anterior* named *intercostal*, are continued between the ribs to the front of the chest: their anatomy has been learnt in the dissection of the thorax and upper limb.

Intercostal artery.

The INTERCOSTAL ARTERY has an almost exact correspondence with the dorsal nerve in its branching and distribution.

SECTION IV.

THE SPINAL CORD AND ITS MEMBRANES.

Cord is contained in spinal canal, invested by membranes.

THE spinal cord (medulla spinalis) gives origin to the spinal nerves, and is lodged in the canal bounded by the bodies and neural arches of the vertebræ. It is invested by prolongations of the membranes of the brain, which form sheaths around and support it.

Dissection. After all the muscles have been taken from the arches and spines of the vertebræ, the spinal canal is to be opened by sawing through the laminæ on each side, close to the articular processes; and the cuts of the saw should extend to the lower end of the sacrum, but not higher in the neck than the fourth cervical vertebra. As it is difficult to use the saw in the hollow of the lumbar region, a chisel and a mallet will be found useful to complete the division of the neural arches. Dissection to show the cord

The tube of the dura mater is covered by some veins and fat, and by a loose areolar tissue containing fluid sometimes, especially at the lower part. The fat may be scraped away with the handle of the scalpel; and the lateral prolongations of the membrane through the invertebral foramina are to be defined. and the membranes.

MEMBRANES OF THE CORD (figs. 190 and 195, p. 540). Three membranes, like those on the brain, surround the cord, viz., an external tube of dura mater, an internal covering of pia mater, and an intermediate sheath of arachnoid. Spinal meninges are three in number.

The DURA MATER (*a*) is the strongest tube, and is continuous with the membrane lining the interior of the skull. It forms a loose sheath (theca) along the spinal canal as far as the last lumbar vertebra; and then tapering gradually it ends opposite the second or third piece of the sacrum in a slender impervious cord which is continued to the back of the coccyx (fig. 194 *b*). The capacity of the sheath greatly exceeds the dimensions of the cord; and it is larger in the neck and loins than in the dorsal region. Dura mater surrounds cord loosely; lower ending; size of sheath;

On the outer aspect the spinal dura mater is smooth, in comparison with that in the skull, for it does not act as a periosteum to the bones. Between it and the wall of the canal are some vessels and fat; and it is connected to the posterior common ligament of the vertebræ by a few fibrous bands. connections;

On each side the durer mata sends offsets along the spinal nerves in the intervertebral foramina; and these offsets become gradually longer below (fig. 194), where they form tubes which enclose the sacral nerves, and lie for some distance with the spinal canal. In the centre between the lowest offsets on the nerves, is the slender fibrous cord (*b*), which blends with the periosteum covering the back of the coccyx. offsets on nerves; median inferior process.

Dissection. To remove the spinal cord with the sheath of the dura mater from the body, the lateral processes in the intervertebral foramina, with the contained nerves, are to be cut; and one or two of them in the dorsal region should be followed outwards beyond the apertures by cutting away the surrounding bone. The central prolongation may be now detached from the coccyx; and the membranes are to be divided opposite the fourth cervical vertebra, and to be removed with the contained cord, which has already been severed in the removal of the brain, by cutting the bands that attach the dura mater to the posterior common ligament. Dissection to remove cord,

When the cord is taken out, place the anterior surface uppermost, with the lateral offsets widely separated. To show the arachnoid covering, the dura mater is to be slit along the middle as far as the and see next covering.

small terminal fibrous cord before referred to; but the membrane is to be raised while it is being cut through, so that the loose arachnoid on the cord may not be injured. After its division, fasten back the dura mater to a long cork strip with pins.

Deep surface of dura mater.

The inner surface of the dura mater is now seen to be smooth

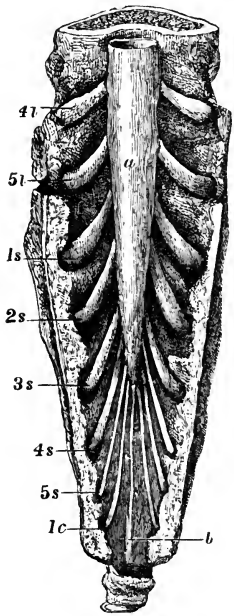


FIG. 194. — LOWER END OF THE DURA MATER WITH ITS CENTRAL AND LATERAL PROCESSES.

a. Sheath of dura mater.

b. Central fibrous band fixing it to the coccyx. The lateral offsets encasing the last two lumbar, the five sacral, and the coccygeal nerves are also shown. Each nerve is marked by the numeral, and the first letter of its name.

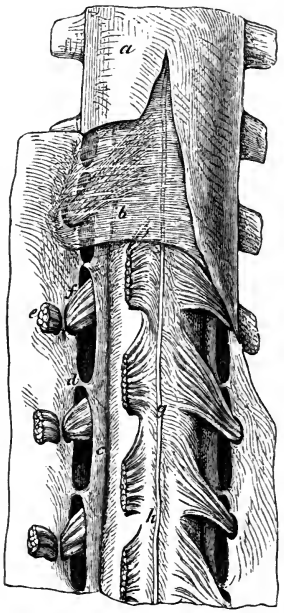


FIG. 195.—MEMBRANES OF THE SPINAL CORD.

a. Dura mater cut open and reflected.

b. Small part of the translucent arachnoid.

h. Pia mater, closely investing the spinal cord.

c. Ligamentum denticulatum on the side of the cord, shown by cutting through the anterior roots of the nerves.

d. Processes joining it to the dura mater.

e. Anterior roots of the nerves, cut; and *f*, posterior roots, each entering a separate hole in the dura mater.

g. Linea splendens.

and shining, and everywhere free except at the spots along each side where it is perforated by the nerves, and where it gives attachment to the processes of the ligamentum denticulatum. The cavity between the dura mater and the arachnoid is named the *subdural space*.

Subdural space.

Arachnoid membrane is loose,

The ARACHNOID (fig. 195, *b*) is the thin translucent covering of the cord immediately beneath the dura mater. It surrounds the

cord loosely, so as to leave a considerable interval between the two —the *subarachnoid space*. The loose sheath is largest at its lower part, where it envelops the mass of nerves forming the cauda equina. Around the roots of each nerve the arachnoid forms a short tube, which is lost as they perforate the dura mater. and leaves a space beneath.

Dissection. The subarachnoid space may be made evident by placing the handle of the scalpel beneath the membrane, or by putting a piece of the cord in water and blowing air between the arachnoid and pia mater. To show subarachnoid space.

The *subarachnoid space* separates the arachnoid membrane from the spinal cord invested by the pia mater. It is larger below than above, and is occupied by the *cerebro-spinal fluid*. Superiorly it is continuous with the cranial subarachnoid space; and it communicates with the cavity in the interior of the brain by means of an aperture in the lower part of the roof of the fourth ventricle (the *foramen of Majendie*). Along the back of the cord the space is imperfectly divided by a median partition (*septum posticum*) composed of bundles of fibrous tissue, which is most developed in the neck. Similar fine trabeculæ pass between the posterior nerve-roots and the arachnoid. The subarachnoid space also contains the ligamentum denticulatum, and the roots of the spinal nerves, with some vessels. Subarachnoid space; contains a fluid, and; opens into ventricles of brain; an imperfect septum behind.

Dissection. In order to see the next covering of the cord, with the ligamentum denticulatum, the arachnoid membrane is to be taken away; and two or three of the anterior roots of the upper dorsal nerves may be cut through and reflected, as in fig. 195. Dissection of third covering.

The PIA MATER (fig 195, *h*) is much less vascular on the spinal cord than on the brain. Thicker and more fibrous in its nature, the membrane closely surrounds the cord with a sheath, and sends a thin fold into the anterior median fissure; it furnishes coverings to the roots of the spinal nerves. Pia mater; supports the cord, gives offsets.

The outer surface of the pia mater is rough. Along the front is a median fibrous band (*linea splendens*; fig. 195, *g*); and on each side another fibrous band, the ligamentum denticulatum, is attached to it. In the cervical region the membrane has usually a rather dark colour, due to the presence of pigment cells in it. Fibrous bands.

Where the spinal cord ceases, viz., about the lower edge of the body of the first lumbar vertebra, the sheath of the pia mater contracts, and gives rise to a slender thread-like prolongation, the *filum terminale* or *central ligament of the cord* (fig. 197 *d* p. 546). This contains a little nervous substance in its upper part; and below, it blends with the central impervious process of the dura mater. A vein and artery accompany the filum terminale, and distinguish it from the surrounding nerves. It ends below in a small fibrous cord, the filum terminale.

The ligamentum denticulatum (fig. 195, *c*) is a white, fibrous band on each side of the spinal cord, and has received its name from its serrated appearance. It serves to support the cord, which is fixed by it to the sheath of the dura mater. The dentate ligament

Situate between the anterior and posterior roots of the nerves, the band reaches upwards to the beginning of the medulla oblongata, is fixed on one side to cord,

and ends below on the pointed extremity of the cord, Internally it is united to the pia mater. Externally it ends in a series of tri-

and on other to dura mater;

angular or tooth-like projections (*d*), which are fixed at intervals into the dura mater, each being about midway between the apertures of the roots of the spinal nerves. There are twenty or twenty-one denticulations, of which the first is attached to the dura mater opposite the margin of the occipital foramen, and the last, opposite the twelfth dorsal or the first lumbar vertebra.

number and attachment of points.

Vessels and nerves of dura mater;

Vessels and nerves of the membrane. The spinal *dura mater* has but few vessels in comparison with that in the skull, as it has not the same periosteal office. Filaments of the sympathetic and spinal nerves are furnished to the membrane.

of arachnoid;

The *arachnoid* has no vessels; and proof of its containing nerves in man is yet wanting.

of pia mater.

The *pia mater* has a network of vessels in its substance, though this is less marked here than on the brain; and from them offsets enter the cord. In the membrane are many nerves derived from the sympathetic and the posterior roots of the spinal nerves.

Dissection of roots of nerves,

Dissection. The arachnoid membrane is to be taken away on one side; and the nerve roots are to be traced outwards to their transmission through apertures in the dura mater.

and the ganglion.

One of the offsets of the dura mater, which has been cut off some length, is to be laid open to expose the contained ganglion. The student should define the ganglion, showing its bifid condition at the inner end (fig. 196, *b*), and should trace a bundle of threads of the posterior root into each point. The anterior root, consisting also of two bundles of threads, is to be followed over the ganglion to its union with the posterior root beyond the ganglion.

Trunks of spinal nerves.

Spinal Nerves. There are thirty-one pairs of spinal nerves; and each nerve is constructed by the blending of two roots (anterior and posterior) in the intervertebral foramen.

Number and groups.

They are divided into groups corresponding with the regional subdivisions of the spinal column, viz., cervical, dorsal, lumbar, sacral, and coccygeal. In each group the nerves are the same in number as the vertebræ, except in the cervical region, where they are eight, and in the coccygeal region where there is only one.

Relation of nerves to vertebræ.

The cervical nerves from the first to the seventh pass out above the several vertebræ; and the eighth is below the last cervical vertebra; the succeeding nerves are placed each below its corresponding vertebra.

Primary divisions.

Each nerve divides into two primary branches, anterior and posterior; the former of these is distributed to the front of the body and the limbs; and the latter is confined to the hinder part of the trunk.

Roots, anterior and posterior.

Roots of the nerves (fig. 196). Two roots (anterior and posterior) attach the nerve to the spinal cord; and these unite together to form a common trunk in the intervertebral foramen. The posterior root is marked by a ganglion, but the anterior root is aganglionic.

The *posterior or ganglionic roots* (fig. 196, A, *b*) are larger than the anterior, and are formed by thicker and more numerous fibrils. They are attached to the side of the cord between the posterior and lateral columns in a straight line, which they preserve even to the last nerve.

Posterior larger than anterior.

forms two bundles

In their course to the trunk of the nerve the fibrils converge to an aperture in the dura mater, opposite the intervertebral foramen; as they approach that aperture they are collected into two bundles (fig. 196, B, *b*) which, lying side by side, receive a sheath from the dura mater, and enter the two points of the intervertebral ganglion.

that enter the ganglion.

The *intervertebral ganglion* (fig. 196 A, *c*) is reddish in colour and oval in shape; and its size is proportioned to that of the root. By means of the previous dissection, the ganglion may be seen to be bifid at the inner end (fig. 196 B), where it is joined by the bundles of filaments of the root (*b*); or the root might be said to possess two small ganglia, one for each bundle of filaments, which are blended at their outer ends.

Ganglia: form, and size; each is bifid.

Sometimes the first or suboccipital nerve is without a ganglion.

The *anterior* or *aganglionic roots* (fig. 196 A, *a*) arise from the side of the spinal cord by filaments which are attached irregularly—not in a straight line, and approach near the middle fissure at the lower end of the cord.

Taking the same direction as the posterior root to the intervertebral foramen, the fibrils enter a distinct opening in, and have a separate sheath of, the dura mater. In their farther course to the trunk of the nerve they are gathered into two bundles (fig. 196 B, *a*), and pass over the ganglion without joining it. Finally, the anterior root blends with the posterior beyond the ganglion, to form the trunk of the nerve.

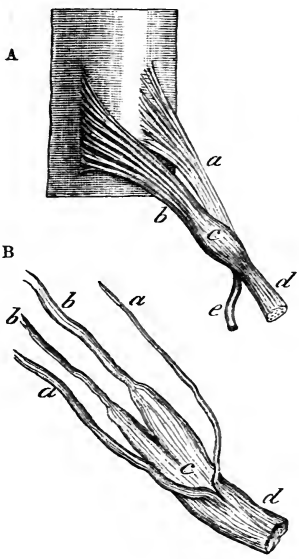


FIG. 196.

A. PLAN OF THE ORIGIN OF A SPINAL NERVE FROM THE SPINAL CORD.

a. Anterior root.
b. Posterior root.
c. Ganglion on the posterior root.
d. Anterior primary branch.
e. Posterior primary branch of the nerve-trunk.

Anterior root is without ganglion,

B. A DRAWING TO SHOW THE ARRANGEMENT OF THE NERVE-ROOTS, AND THE FORM OF THE GANGLION IN A LUMBAR NERVE.

b, *b*. Posterior root gathered into two bundles of threads.

pierces dura mater and joins posterior root beyond ganglion.

c. The ganglion, bifid at the inner end.

a, *a*. Filaments of the anterior root, also gathered into two bundles.

Characters of roots.

Characters of the roots. Besides variations in the relative size of the two roots, the following characters are to be noted :—

Some sets of fibrils join ;

Union of the fibrils. The fibrils of contiguous anterior roots may be intermingled, and the fibrils of the neighbouring posterior roots may be connected in a like manner ; but the anterior is never mixed with the posterior root.

posterior root larger,

Size of the roots to each other. The posterior root is larger than the anterior, except in the suboccipital nerve ; and the number of the filaments is also greater. Farther, the posterior is proportionally larger in the cervical than in any other group ; in the dorsal nerves there is but a very slight difference in favour of the hinder root.

proportionally largest in neck.

Roots are largest for nerves of limbs.

Size of both roots along the cord. Both roots are larger where the nerves for the limbs arise than at any other part of the cord ; and they are largest in the nerves to the lower limbs. They are smallest at the lower extremity of the cord.

Oblique in their course,

Direction and length of the roots. As the apertures of transmission from the spinal canal are not generally opposite the place of origin of the nerves, the roots are for the most part directed obliquely. This obliquity increases from above downwards ; for in the upper cervical nerves the roots are horizontal ; but in the lumbar and sacral nerves they have a vertical direction around the filum terminale (fig. 197) ; and the bundle of long nerve-roots descending from the end of the spinal cord, from its resemblance to a horse's tail, is named the *Cauda Equina.*

most so inferiorly,

where they form cauda equina.

Length increases from above downwards.

The length of the roots increases in proportion to their obliquity. Thus, the distance between the origin and the place of exit of the roots of the lowest cervical nerve equals the depth of one vertebra ; in the lowest dorsal nerve it amounts to the depth of two vertebræ ; and in the lumbar and sacral nerves each succeeding root becomes nearly a vertebra longer, for the cord does not reach beyond the first lumbar vertebra.

Union of the roots in intervertebral foramen.

Place of union of the roots. Commonly the roots unite as before stated in the intervertebral foramina ; and the trunk of the nerve bifurcates at the same spot into anterior and posterior primary branches (fig. 196, *d* and *e*). But deviations from this arrangement are found at the upper and lower ends of the spinal column in the following nerves.

except in first two cervical,

The roots of the first two cervical nerves join on the neural arches of the corresponding vertebræ ; and the anterior and posterior primary branches diverge from the trunks in that situation.

the sacral,

In the sacral nerves the union of the roots takes place within the spinal canal ; and the primary branches of the nerves issue by the apertures on the front and back of the sacrum.

and coccygeal nerves.

The roots of the coccygeal nerve are also united in the spinal canal ; and the anterior and posterior branches of its trunk escape by the lower aperture of that canal.

Situation of ganglia.

Situation of the ganglia. The ganglia are placed commonly in the intervertebral foramina, but where the position of these apertures

Exceptions in cervical,

is irregular, as at the upper and lower extremities of the spinal

column, they have the following situation :—In the first two nerves they lie on the neural arches of the atlas and axis. In the sacral nerves they are contained in the spinal canal ; and in the coccygeal nerve the ganglion is usually within the sac of the dura mater. sacral, and coccygeal.

VESSELS OF THE SPINAL CORD. The arteries on the surface of the cord are anterior and posterior spinal. Arteries of cord.

The *anterior spinal artery* occupies the middle line of the cord beneath the fibrous band before alluded to in that position. It begins by the union of two small branches of the vertebral artery within the skull, and it is continued to the lower end of the cord by a series of anastomotic branches, which are derived from the vertebral and ascending cervical arteries in the neck, and from the intercostal arteries in the dorsal region. Inferiorly it supplies the roots of the nerves forming the cauda equina, and ends on the central fibrous prolongation of the cord. The branches of this artery ramify in the pia mater, some entering the median fissure. Anterior spinal, a single artery ; termination ; offsets.

The *posterior spinal arteries*, one on each side, are continued from the upper to the lower part of the cord, behind the roots of the nerves. These vessels are furnished from the vertebral artery within the skull, and their continuity is maintained by a series of anastomotic offsets, which enter the canal along the spinal nerves. Dividing into small branches, the vessels of opposite sides form a free anastomosis around the posterior roots, and some twigs enter the posterior septa of the cord. Posterior arteries are two ; lie on sides of cord.

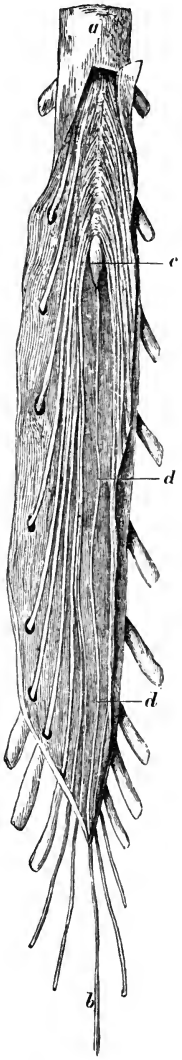
The *veins of the spinal cord* are very tortuous and form a plexus on the surface. At intervals larger trunks arise, which accompany the spinal nerves to the intervertebral foramina, and end in the veins outside the spinal canal. Near the top of the cord the veins are united into two or more small branches, which, communicating with the intraspinal veins, join in the skull the inferior cerebellar veins, or the inferior petrosal sinuses. Veins : termination ; at top of cord.

The SPINAL CORD (medulla spinalis) is the elongated cylindrical part of the cerebro-spinal centre, which is enclosed within the spinal canal. Invested by the membranes before examined, the cord occupies about two-thirds of the length of the canal, and is much smaller than the bony case surrounding it. Situation of the cord.

The extent of the spinal cord is from the lower margin of the foramen magnum of the occipital bone to the lower border of the first lumbar vertebra, but its termination inferiorly may be a little higher or lower than that spot. In the embryo before the third month the cord reaches the whole length of the spinal canal ; but it gradually recedes as the surrounding bones enlarge faster than it, until it takes the position it has in the adult. Its length is usually from sixteen to eighteen inches. Extent varies below, and in the embryo. Length.

Above, the cord joins the medulla oblongata ; and below it ends in a small tapering part (*conus medullaris*), from which the filum terminale (fig. 197, *d*) is continued downwards. The lower end of the conus medullaris is sometimes marked by one or two irregular swellings. Inferior termination in the adult.

The size of the spinal cord is much increased where the nerves Two swellings on it.



Anterior surface, how known.

Dissection to see constituents of cord.

Furrows of the cord are anterior median,

posterior median,

FIG. 197.—MEMBRANES OF THE SPINAL CORD LAID OPEN, TO SHOW THE LOWER END OF THE CORD WITH THE FILUM TERMINALE.

a. Dura mater, and *b*, the fibrous band fixing it to the coccyx.

c. Pointed lower end of the cord (conus medullaris).

d. Filum terminale of the cord.

of the limbs are attached. There are, therefore, two enlargements on it, viz., cervical or brachial, and lumbar or crural; the one in the neck reaches from the first cervical to the first dorsal vertebra; the other is smaller, and is on a level with the eleventh and twelfth dorsal vertebræ. In the upper enlargement the greatest thickness is from side to side; but in the lower swelling the measurement from before backwards nearly equals the transverse.

While the pia mater remains on the cord, the anterior surface is distinguished from the posterior by the central fibrous band and by the anterior spinal artery; as well as by the irregular line of the anterior nerve-roots, which approach the middle towards the lower end.

Dissection. For the examination of the structure the student will require a piece of fresh cord which has been hardened in spirit and formalin, since the cord which is obtained from the body at this period is not fitted for the purpose of dissection. Supposing the pia mater with the roots of the nerves removed on one side, the student will be able to observe the following divisions of the cord.

SULCI OF THE CORD (fig. 198). The *anterior median fissure* occupies the middle line of the front of the cord in its whole length, and penetrates about one-third of the thickness of it. It is lined by a fold of the pia mater, and is deepest towards the lower end of the cord. White medullary substance bounds the fissure; and at the bottom of it the white fibres are transverse, and are separated by apertures for blood-vessels.

Along the back of the cord, also in the middle line, there is a narrow groove, from which a process of the pia mater called the *posterior*

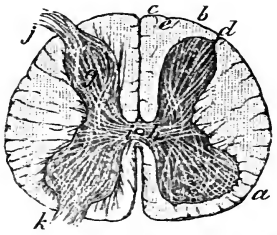
median septum extends forwards nearly to the centre of the medulla, separating the nervous substance of the right and left halves. Vessels of the posterior surface of the cord enter in the septum.

The *lateral furrow* (fig. 198, *d*) is a shallow groove along the line of attachment of the fasciculi of the posterior roots. lateral,

Between the posterior median and the lateral grooves another slight furrow, the *posterior intermediate*, may be seen in the upper part of the cord (fig. 198, *e*). and posterior intermediate.

DIVISIONS OF THE CORD. Each half of the cord between the median sulci is divided into two by the lateral furrow (fig. 198, *d*); the part in front of that groove and the posterior roots of the nerves is called the antero-lateral column (*a*); and the part behind, the posterior column (*b*). The cord is divided into

The *antero-lateral column* (fig. 198, *a*) includes rather more than two-thirds of the half of the cord, extending backwards to the posterior roots of the nerves, and gives attachment to the anterior nerve roots (*k*). This part of the cord is sometimes described as consisting of anterior and lateral columns, the two being separated by the anterior roots of the nerves.



antero-lateral column,

FIG. 198.—A SECTION OF THE SPINAL CORD IN THE CERVICAL REGION TO SHOW ITS COMPOSITION AND DIVISIONS. IN THE MIDDLE LINE BELOW IS THE ANTERIOR MEDIAN FISSURE, AND ABOVE ARE THE POSTERIOR MEDIAN GROOVE AND SEPTUM.

The *posterior column* (fig. 198, *b*) is situate between the lateral furrow (*d*), with the posterior roots of the nerves, and the posterior median septum. In the *cervical region*, the posterior intermediate sulcus(*e*) marks off a small inner portion, which is named the *posterior median column* (*c*); and the remainder is then distinguished as the *posterior external column* (*b*). posterior column,

d. The lateral sulcus.
e. The posterior intermediate sulcus.

Columns:

a. Antero-lateral.
b. Posterior external.
c. Posterior median. with median and external parts,

Composition:

g. Grey crescent, surrounded by white fibres.
h. Grey transverse commissure, and *i*, canal of the cord in it.
j. Posterior, and *k*. anterior root of a nerve entering the grey crescent. and commissure.

A narrow central piece, the *commissure of the cord*, unites the halves between the anterior median fissure and the posterior median septum.

COMPOSITION OF THE CORD (fig. 198). Horizontal sections of the cord in the cervical, dorsal, and lumbar regions, show more distinctly its division into halves, with the *commissural* or connecting piece between them, and the varying proportion of its grey and white matter in the different parts. The cuts demonstrate the existence of a mass of grey matter in the interior, which is arranged in the form of two crescents (one in each half), united by a cross piece, and surrounded by white substance. Cord consists of grey and white matter.

The commissure:

The *commissure* consists of two parts, viz., a transverse band of grey matter (fig. 198, *h*), with a white stratum in front.

the grey part,

with its central canal

The grey transverse band (*posterior* or *grey commissure*) connects the opposite crescents, and is placed rather nearer the front than the back of the cord. In its centre is the shrunken canal of the spinal cord (fig. 198, *i*), which is best seen in the fœtus. It reaches the whole length of the cord, and a cross section shows it as a round spot. Above, the canal opens on the floor of the fourth ventricle; and below, it is continued into the filum terminale.

lined by epithelium;

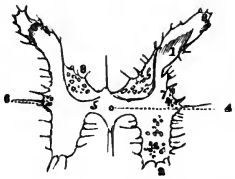
It is lined by a columbar ciliated epithelium, and is obstructed by a granular material near the upper end.

the white part.

The *anterior* or *white commissure* is best marked opposite the cervical and lumbar enlargements on the cord, and is least developed in the dorsal region.

The half of cord.

Lateral half. In the half of the cord, as in the commissure, grey and white portions exist; the former is elongated from before backwards, being crescentic in shape, and is quite surrounded by white matter.



The grey crescent.

The *grey matter* (fig. 198 *g*), has its extremities or *cornua* directed towards the roots of the nerves, and the convexity to the middle line. The crescentic masses in the opposite halves of the cord are united by the grey commissure.

FIG. 199.—OUTLINE OF THE GREY SUBSTANCE IN THE SPINAL CORD, NEAR THE MIDDLE OF THE DORSAL REGION (LOCKHART CLARKE).

1. Caput cornu posterioris.
2. Anterior cornu.
3. Substantia gelatinosa.
4. Central canal of the cord.
5. Posterior commissure.
6. Intermediate process.
7. Cervix cornu posterioris.
8. Posterior vesicular column.

Posterior cornu:

Taking a cross section of the dorsal region as an example: the *posterior cornu* is long and slender (fig. 199), and reaches nearly to the surface along the lateral fissure.

its parts.

It is rather narrow at its base (*cervix*, [7]), and enlarged towards its extremity (*caput*, [1]), where it is surmounted by a semi-transparent layer which has been named the *substantia gelatinosa* (3). There is also on the inner side of the cervix of the posterior cornu a special portion of grey matter containing nerve-cells, the *posterior vesicular column* of Clarke (8), which is most developed in the lower dorsal region.

Anterior cornu.

The *anterior cornu* (fig. 199) is shorter and thicker than the posterior, and projects towards the anterior roots without reaching the surface. Its end has an irregular or zigzag outline.

Intermediate process.

A third smaller projection of the grey matter is seen in the upper part of the dorsal region of the cord, on the outer side of the crescent, between the anterior and posterior horns: this is known as the *intermediate process* (Gowers) or the *lateral cornu* (fig. 199.)

White substance.

The *white substance of the cord* is composed chiefly of medullated nerve-fibres disposed in longitudinal bundles, which are enclosed by irregular septa of connective tissue prolonged from the pia mater on

the surface. Three larger processes of the pia mater extend into the back of the cord ; these are the *posterior median septum* already referred to, and the *posterior intermediate septum* on each side, seen only in the cervical region, which passes forwards from the furrow of the same name, and separates the posterior median and postero-external columns.

Modifications in the grey and white substance. The white substance much exceeds the grey in quantity in the cervical and dorsal regions ; but it is less abundant in proportion to the grey matter in the lumbar enlargement. The grey substance is least in amount

Grey and white substance vary.

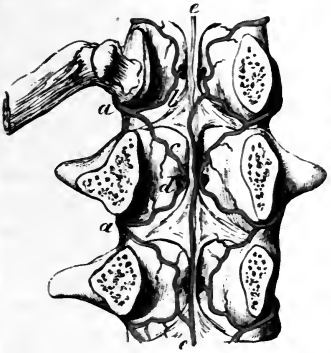


FIG. 200.—INTRASPINAL ARTERIES IN THE LOINS.

a. Branch of a lumbar artery.
b. Ascending, and *c*, descending offset.
d. Offset to the body of the vertebra on each side.
e. Central artery formed by offsets from the lateral loops.

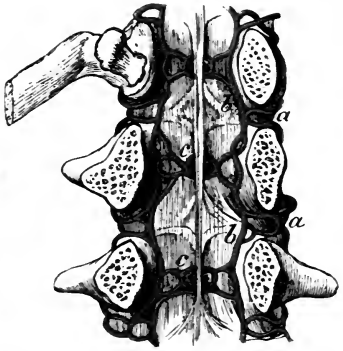


FIG. 201.—INTRASPINAL VEINS IN THE LOINS.

a. Branch to join a lumbar vein.
b. Anterior longitudinal vein, one on each side.
c. Veins from the bodies of the vertebræ.

in the dorsal region ; the anterior horn is specially large in the cervical region, and in the lumbar enlargement both horns are large and the grey matter forms a considerable proportion of the substance of the cord. The posterior horn is massive, though not quite so large as the anterior.

The cornua of the grey crescents decrease in length from above down, especially the posterior, and towards the end of the cord they blend in one indented or cruciform mass.

Crescents alter their shape.

INTRASPINAL VESSELS. Arteries supply the cord and its membranes, and the bodies of the vertebræ. The veins form a remarkable plexus within the canal, but this will not be seen unless they have been specially injected.

Vessels of the spinal canal.

The *intraspinal arteries* (fig. 200, *a*) are derived from the vessels along the sides and front of the spinal column, viz., from the vertebral and ascending cervical in the neck, from the intercostal in

Source of the intraspinal arteries.

the back, and from the lumbar and lateral sacral below. They are distributed after the following plan :—

Distribution to the vertebræ

As each artery enters the spinal canal by the intervertebral foramen, it divides into two branches, upper and lower. From the point of division the branches are directed, one (*b*) upwards and the other (*c*) downwards, behind the bodies of the two contiguous vertebræ, and join in anastomotic loops with an offset of the intraspinal artery above and below. From the loops offsets (*d*) are furnished to the periosteum and to the bodies of the vertebræ. Anastomotic twigs connect the arches across the vertebræ.

by loops :

and a central vessel.

The intraspinal vessels produce also a central longitudinal artery (*e*), like that on the front of the spinal cord, which lies on the bodies of the vertebræ, and is reinforced at intervals by offsets from the loops.

Intraspinal veins are large.

The *intraspinal veins* (fig. 201) consist of two anterior longitudinal vessels, which extend the whole length of the spinal canal ; of veins inside the bodies of the vertebræ ; and of a plexus of veins beneath the neural arches.

Anterior longitudinal are on bodies of vertebræ.

The *anterior longitudinal veins* (*b*) are close to the bodies of the vertebræ, one on each side of the posterior common ligament ; and they are irregular in outline, owing to certain constrictions near the intervertebral foramina. They receive, opposite the body of each vertebra the veins (*c*) from that bone ; and through the intervertebral foramina they have branches of communication (*a*) with the veins outside the spine in the neck, the dorsal region, the loins and the pelvis.

Veins of the vertebræ.

Veins of the bodies of the vertebræ. Within the channels in the bodies of the vertebræ are large veins, which join on the front of the bone with veins in that situation. Towards the back of the vertebra they are united in an arch, from which two trunks issue by the large apertures on the posterior surface. Escaped from the bone, the trunks diverge to the right and left, and open into the longitudinal veins.

Posterior spinal veins are in contact with arches.

The *posterior spinal veins* form a plexus between the dura mater and the arches of the vertebræ. A large vein may be said to lie on each side of the middle line, which joins freely with its fellow, and with the anterior longitudinal vein by lateral branches. Offsets from these vessels are directed through the intervertebral foramina, to end in the veins (*a*) at the roots of the transverse processes.

Section V.

DISSECTION OF THE FACE.

Directions. After the dissections of the perineum and of the back have been completed, the body will be turned on to the back and will remain in that position.

First dissect face.

The worker on the head and neck will first dissect the face,

because it is most desirable to have it as fresh as possible. This will usually take two days, and he will then proceed with the triangles of the neck, and it is important that he shall have examined the brachial plexus, and worked up to page 599 at least, in order that the dissector of the upper limb may be free to remove his part at the end of the sixth day after turning the body.

Position. The head is to be placed so that the side of the face being dissected is upwards, as far as the times of the students on the two sides will allow, and it is to be fixed in this position with hooks.

Dissection. It is not easy to make a good dissection of the muscles, nerves and vessels of the face on one side, and the students are advised to arrange together to make out the muscles and nerves on the one side and the muscles and vessels on the other. At the same time a good dissector can display them all on the same side. As a preparatory step, the muscular fibres of the apertures may be made slightly tense by inserting a small quantity of tow or cotton wool between the eyelids and the eyeball, and between the lips and the teeth, and within the cheek.

Dissection. Muscles and nerves, one side; muscles and vessels the other.

First lay bare the orbicularis palpebrarum muscle by making a skin-deep incision round the margin of the orbit, and raising the skin of the lids towards the aperture of the eye (fig. 203, p. 553). Much care must be taken in detaching the skin from the thin and pale fibres of the orbicular muscle in the lids, as there is but little areolar tissue between the two.

How to raise the skin from eyelids

Next the integument is to be removed from the side of the face by one incision in front of the ear from above the zygomatic arch prolonging down the incision already made in the scalp to the angle of the jaw, and another along the lower border of the jaw to the chin: a cut should also be made along the free margin of each lip from the centre to the angle of the mouth, and another round the edge of the nostril. The flap of skin is to be raised from behind forwards, and left adherent along the middle line.

from the face,

On the side of the nose the skin is closely united to the subjacent parts, and must be detached with caution. Around the mouth are the orbicular muscular fibres of the lips, and from this many fleshy slips extend both upwards and downwards, but they are all marked distinctly enough to escape injury, with the exception of the small risorius muscle which goes from the corner of the mouth towards the ramus of the lower jaw. While removing the fat from the muscles, each fleshy slip may be tightened with hooks.

and from side of nose; to clean muscles around mouth.

The facial vessels and their branches will come into view as the muscles are cleaned (fig. 204, p. 558); the branches of the facial nerve will be seen passing forwards from the parotid gland (fig. 205, p. 562). Over the lower part of the parotid gland, near the angle of the jaw, the facial branches of the great auricular nerve will be found.

Facial vessels,

In front of the ear is the parotid gland, and its duct (which is on a level with the meatus auditorius, and pierces the middle of the cheek) will be traced forwards.

and parotid duct.

In the face the muscles form three groups.

MUSCLES OF THE FACE (fig. 203). The superficial muscles of the face are disposed in *three groups*: one of *the nose*, another of the *eyelids and eyebrow*, and a third of the *aperture of the mouth*. One of the muscles of mastication, viz., the masseter, is partly displayed at the hinder part of the face covering the ramus of the lower jaw.

Muscles of nose.

MUSCLES OF THE NOSE (fig. 202). These muscles are the following: pyramidalis nasi, compressor naris, levator labii superioris alæque nasi, dilator naris, and depressor alæ nasi.

Pyramidalis nasi:

The PYRAMIDALIS NASI (fig. 202 [1]), is a small fleshy slip that covers the nasal bone, and appears to be a continuation of the innermost part of the frontalis muscle. Its fibres are attached above to the skin of the forehead; below, they end in the aponeurosis of the compressor muscles over the cartilaginous part of the nose. Its inner border meets the muscle of the opposite side.

use.

Action. This muscle draws down the skin of the centre of the forehead, and produces transverse wrinkles at the root of the nose.

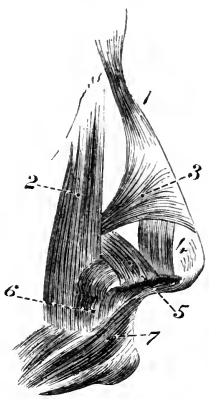


FIG. 202.—MUSCLES OF THE NOSE

1. Pyramidalis nasi.
2. Common elevator of the nose and lip.
3. Compressor naris.
4 and 5. The two slips of the dilatator naris.
6. Depressor alæ nasi.
7. Naso-labial slip of orbicularis oris.

Compressor naris:

COMPRESSOR NARIS. This muscle (fig. 202 [3]) is not well seen till after the examination of the following one, by which it is partly concealed. Triangular in shape, it *arises* by its apex from the upper maxillary bone near the anterior nasal aperture. The fibres are directed inwards, spreading out at the same time, and end in an aponeurosis, which covers the cartilaginous part of the nose, and is continued into the opposite muscle.

use.

Action. It stretches the skin over the cartilaginous part of the nose, and depresses the tip of the organ.

Common elevator of wing of nose and upper lip:

The LEVATOR LABII SUPERIORIS ALÆQUE NASI (fig. 202 [2], and fig. 203) is placed by the side of the nose, and *arises* from the nasal process of the upper maxillary bone, in front of the attachment of the orbicularis. The fibres pass downwards, and the most internal are attached by a narrow slip to the ala of the nose, while the rest are inserted into the adjoining part of the skin of the upper lip. Near its origin the muscle is partly concealed by the orbicularis palpebrarum, but in the rest of its extent it is subcutaneous. Its outer border joins the elevator of the upper lip.

use.

Action. This muscle raises the upper lip and wing of the nose, forming wrinkles in the overlying skin.

Dilator of nostril:

DILATATOR NARIS. In the dense tissue on the outer side of the nostril are a few muscular fibres, both at the fore and back part of

that aperture (fig. 202), to which the above name has been given: they are seldom visible without a lens. The *anterior* slip (4) passes from the cartilage of the aperture to the integument of the margin of the nostril; and the *posterior* (5) arising from the upper jawbone and the small quadrate cartilages, ends also in the integuments of the nostril. anterior and posterior parts:

Action. The fibres enlarge the nasal opening by raising and everting the outer edge. use.

The DEPRESSOR ALÆ NASI (fig. 202 6) will be seen if the upper lip is everted, and the mucous membrane is removed by the side of the frænum of the lip. It *arises* below the nose from the incisor fossa of the superior maxilla, and ascends to be *inserted* into the septum narium and the posterior part of the ala of the nose. Depressor of wing:

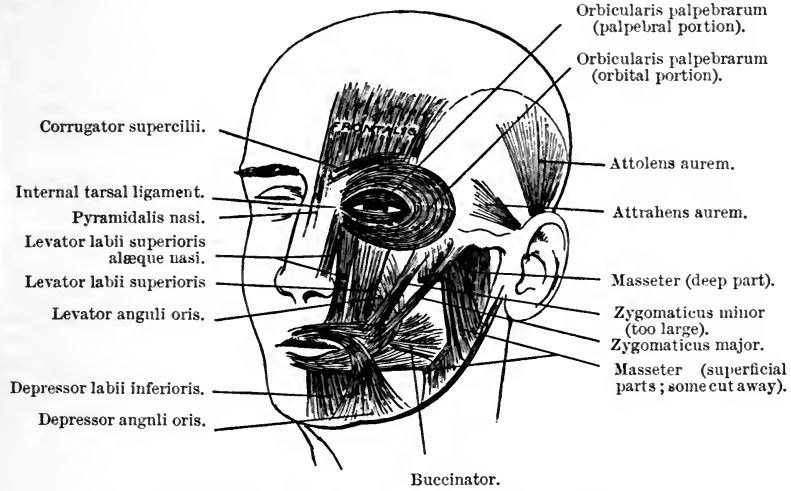


FIG. 203.—DIAGRAM OF THE MUSCLES OF THE FACE.

Action. By drawing down and turning in the edge of the dilated nostril, it restores the aperture to its usual size. use.

MUSCLES OF THE EYELIDS. The muscles of the eyelids and eyebrow are four in number, viz., orbicularis palpebrarum, corrugator supercilii, levator palpebræ superioris. and tensor tarsi *: the two latter are dissected in the orbit, and will be then described. Four muscles of eyelids and brow.

The ORBICULARIS PALPEBRARUM (fig. 203) is the sphincter muscle closing the opening between the eyelids. It is a flat and thin layer, which extends from the margin of the lids beyond the circumference of the orbit. From a difference in the characters of the fibres, a division has been made of them into two parts—outer, or *orbital*, and inner, or *palpebral*. Orbicularis palpebrarum: two parts.

* The tensor tarsi muscle is sometimes described as part of the orbicularis.

Orbital or external, attached internally; forms concentric bundles.

The *orbital fibres* are the best marked, and are fixed only at the inner side of the orbit. Above the internal tarsal ligament (which is the short fibrous band at the junction between the two eyelids, stretching from the palpebral fissure to the inner margin of the orbit) the fibres are attached to the nasal process of the superior maxillary and to the internal angular process of the frontal bone; and, below the ligament, to the orbital margin of the superior maxillary bone. From this origin the fibres are directed outwards, giving rise to ovals, which lie side by side, and increase in size towards the outer edge of the muscle, where they project beyond the margin of the orbit. Some of the peripheral fibres spread upwards to the skin of the forehead, and others downwards to that of the cheek.

Internal or palpebral part. attached at both ends. Ciliary bundle.

The *palpebral fibres*, paler and finer than the orbital, occupy the eyelids, and are fixed at both the outer and inner sides of the orbit. Internally they *arise* from the upper and lower margins of the internal tarsal ligament: externally they end in the much smaller external tarsal ligament, by means of which they are attached to the malar bone, and a few may blend with the orbital part of the muscle. Close to the cilia, or eyelashes, the fibres form a small pale bundle, which is sometimes called the *ciliary bundle*.

Relations.

The muscle is subcutaneous: and its circumference is blended above with the frontalis. Beneath the upper half of the orbicularis, as it lies on the margin of the orbit, is the corrugator supercilii muscle with the supraorbital vessels and nerve; and beneath the lower half is a portion of the elevator of the upper lip. The outer fibres are joined occasionally by slips to other contiguous muscles below the orbit.

Use of inner and outer fibres.

Action. The *palpebral fibres* cause the lids to approach each other, shutting the eye; and in forced contraction the outer commissure is drawn inwards. In closing the eye the lids move unequally—the upper being much depressed, and the lower slightly elevated and moved horizontally inwards.

When the *orbital fibres* contract, the eyebrow is depressed, and the skin over the edge of the orbit is raised around and brought inwards in front of the eye, so as to protect the ball. Elevation of the upper lip accompanies contraction of the outer part of the orbicularis, owing to the associated action of the levator labii superioris and zygomatic muscles.

Corrugator supercilli inserted into skin: use.

The CORRUGATOR SUPERCILII (fig. 203) is beneath the orbicularis, near the inner angle of the orbit. Its fibres *arise* from the inner part of the superciliary ridge of the frontal bone, and are directed outwards between the bundles of the orbicularis to be inserted into the skin above the inner half of the eyebrow. It is a short muscle, and is distinguished by the closeness of its fibres.

Action. It draws inwards and downwards the mid-part of the eyebrow, wrinkling vertically the skin near the nose, and stretching that outside its place of insertion.

Muscles of the mouth.

MUSCLES OF THE MOUTH (fig. 203). The muscles of the mouth and lips include the elevators of the upper lip and of the angle of the

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MUSCLES and lips incl

mouth, the depressors of the lower lip and of the angle of the mouth, the zygomatic and risorius muscles, and a wide muscle of the cheek closing the space between the jaws (the buccinator). Lastly, an orbicular muscle surrounds the opening, but it is largely composed of fibres of the preceding muscles.

Elevator of upper lip:

The LEVATOR LABII SUPERIORIS extends vertically from the lower margin of the orbit to the orbicularis oris. It *arises* from the upper maxilla above the infraorbital foramen and from the innermost part of the malar bone, and is *inserted* into the skin of the upper lip, its fibres interlacing with those of the orbicularis. Near the orbit the muscle is overlapped by the orbicularis palpebrarum, but below that spot it is subcutaneous. By its inner side relations: it joins the common elevator of the ala of the nose and upper lip; and to its outer side lie the zygomatic muscles, the small one joining it. Beneath it are the infraorbital vessels and nerve.

Action. By the action of this muscle the upper lip is raised, use. and the skin of the cheek is bulged below the eye.

Depressor of lower jaw:

The DEPRESSOR LABII INFERIORIS is opposite the elevator of the upper lip, and has much yellow fat mixed with its fibres. The muscle has a wide *origin* from a depression on the front of the lower jaw, reaching from near the symphysis to a little beyond the mental foramen; ascending thence it is *inserted* into the skin of the lower lip. Its inner border joins in the lip the muscle of the opposite side; and its outer is overlapped by the depressor anguli oris.

Action. If one muscle contracts, the half of the lip of the same use side is depressed and everted; but by the use of both muscles, the whole lip is lowered and turned outwards, and rendered tense at the centre.

Elevator of the angle

The LEVATOR ANGULI ORIS has well-marked fibres, and is partly concealed by the levator labii superioris. *Arising* from the canine fossa of the upper jaw below the infraorbital foramen, its fibres descend towards the angle of the mouth, where they are superficial to the buccinator and are partly *inserted* into the skin, but the greater enters orbicularis: number are continued into the orbicularis of the lower lip, and sweep round below the mouth to the opposite side of the middle line.

Action. This muscle elevates the corner of the mouth, and acts use. as an antagonist to the depressor.

Depressor of angle

The DEPRESSOR ANGULI ORIS is triangular in shape. It *arises* from the oblique line on the outer surface of the lower jaw; and ascending to the angle of the mouth, a few of its fibres are there *inserted* into the skin, but the greater number decussate with those of the also joins orbicularis: elevator muscle and pass into the upper part of the orbicularis, and sweep round above the mouth to the opposite side of the middle line. The depressor conceals the mental branches of the inferior dental vessels and nerve. It is united at its origin with the platysma myoides, and near its insertion with the risorius muscle.

Action. The angle of the mouth is drawn downwards by it, as use. is exemplified in a sorrowful countenance.

Zygomatic muscles,

The ZYGOMATIC MUSCLES are directed obliquely from the malar bone towards the angle of the mouth and the upper lip. One is

longer and larger than the other; they are therefore named major and minor.

large and small: The *zygomaticus major arises* from the outer part of the malar bone, and is *inserted* into the skin and mucous membrane at the angle of the mouth.

The *zygomaticus minor arises* from the malar bone in front of the major, and blends with the elevator of the upper lip. This muscle is often absent.

use. *Action.* The large muscle draws upwards and backwards the corner of the mouth, as in laughing; and the small one assists the levator labii superioris in raising the upper lip.

Risorius muscle: The RISORIUS MUSCLE (fig. 185, p. 501) is a thin bundle of fibres, sometimes divided into two or more parts, which *arises* externally from the fascia over the masseter muscle, and is connected internally with the apex of the depressor anguli oris.

use. *Action.* It retracts the corner of the mouth in smiling.

Buccinator muscle: The BUCCINATOR (fig. 203) is the flat and thin muscle of the cheek, and occupies the interval between the jaws. It *arises* from

origin; the outer surface of the alveolar borders of the upper and lower maxillæ, as far forwards in each as the first molar tooth; and in the interval between the jaws behind it is attached to a tendinous

insertion at corner of the mouth; band known as the pterygo-maxillary ligament. From this origin the fibres are directed forwards to the lips, where they pass into the orbicularis; most of the upper fibres descend to the lower lip while many lower ones ascend to the upper lip, a decussation taking place at the corner of the mouth. The highest and lowest fibres enter the corresponding lip.

parts in contact with it; On the cutaneous surface of the buccinator are the different muscles converging to the angle of the mouth; and crossing the upper part is the duct of the parotid gland, which perforates the muscle opposite the second upper molar tooth. Internally the muscle is lined by the mucous membrane of the mouth, and externally it is covered by a fascia (bucco-pharyngeal) that is continued over the pharynx behind. By its intermaxillary origin the buccinator corresponds with the attachment of the superior constrictor of the pharynx.

use on aperture, *Action.* By one muscle the corner of the mouth is retracted, and by the action of both the aperture of the mouth is widened transversely.

on cheek, In mastication the cheek is pressed against the arches of the teeth and food cannot accumulate in the interval, while the corner of the mouth is fixed by the orbicularis.

in expelling air. In the expulsion of air from the mouth, as in whistling, the muscle is contracted so as to prevent bulging of the cheek; but in the use of a blow-pipe it is stretched over the volume of air contained in the mouth, and maintains a continuous stream by its contraction during expiration.

Orbicular muscle of lips includes fibres of buccinator, The ORBICULARIS ORIS is mainly formed by the prolongation of the fibres of the levator and depressor angulis oris and buccinator muscles. The buccinator fibres lie next to the mucous membrane,

and are continued across from side to side. Those of the elevator and depressor muscles, having crossed at the corner of the mouth, turn inwards in the opposite lip, in front of the buccinator fibres, and are inserted into the skin, for the most part crossing the middle line and decussating with the fibres entering on the other side. A compact superficial fasciculus at the red margin of the lip is formed solely by buccinator fibres. In the upper lip there are also two slips arising, the one (*naso-labial*, fig. 202) from the hinder part of the septum narium, the other (*incisive*) from the outer part of the incisor fossa of the superior maxilla, and directed outwards to the corner of the mouth; while in the lower lip there is a similar *incisive* slip attached to the incisor fossa of the inferior maxilla. To see these attachments, the lip must be everted and the mucous membrane carefully raised.

levator and depressor anguli oris,

naso-labial and incisive slips.

Towards the free margin in each lip there are fibres directed obliquely from the skin to the mucous membrane, between the fasciculi of the orbicularis: they constitute the *musc. labii proprius.*

Special fibres of lips.

The inner margin of the orbicularis is free, and bounds the aperture of the mouth; the outer edge blends with the different muscles that elevate or depress the lips and the angle of the mouth. Between the orbicularis and the mucous membrane in each lip are the coronary artery and the labial glands.

Relation of orbicularis,

Action. The buccal portion of the muscle flattens the lips against the teeth, turns inwards the red margin, and gives a linear form to the aperture. The superficial portion, derived from the muscles of the angle of the mouth, brings the lips together both vertically and horizontally, so as to diminish the size of the opening, and causes the free edges of the lips to protrude.

and use.

The LEVATOR MENTI (levator labii inferioris) is a small muscle on the side of the frænum of the lower lip, which is opposite the depressor of the ala of the nose in the upper lip. When the lip has been everted and the mucous membrane removed, the muscle will be seen to *arise* from the incissor fossa of the lower jaw, and to descend to its *insertion* into the integument of the chin. Its position is internal to the depressor of the lip and the attachment of the orbicularis.

Elevator of chin:

Action. It indents the skin of the chin opposite its insertion, and assists in raising the lower lip.

use.

The principal VESSELS OF THE FACE (fig. 204) are the facial and transverse facial arteries with their accompanying veins. The arteries are branches of the external carotid; and the facial vein is received into the internal jugular trunk.

Arteries of the face.

The FACIAL ARTERY (fig. 204, *g*), a branch of the carotid, emerges from the neck, and crosses the base of the lower jaw immediately in front of the masseter muscle. From this point the artery ascends in a tortuous manner, near the angle of the mouth and the side of the nose, to the inner margin of the orbit, where it anastomoses with the terminal branches of the ophthalmic artery. The course of the vessel is comparatively superficial in the mass of fat of the inner part of the cheek. At first it is concealed by the

Facial artery:

course

and relations; platysma while crossing the jaw, but this thin muscle does not prevent pulsation being recognised during life; near the mouth the large zygomatic muscle is superficial to it. The vessel rests successively on the lower jaw, the buccinator muscle, the elevator of the angle

FIG. 204.—EXTERNAL CAROTID AND ITS SUPERFICIAL BRANCHES ("ANATOMY OF THE ARTERIES," QUAIN).

a. Common carotid.
b. Internal jugular vein.
c. Internal carotid.
d. External carotid.
e. Superior thyroid.
f. Lingual.
g. Facial.
h. Internal maxillary.
i. Superficial temporal.
m. Supraorbital.
n. External nasal.
o. Angular branch of facial
p. Lateral nasal.
r. Superior coronary.
s. Inferior coronary.
t. Inferior labial.
u. Submental artery.

of the mouth, and the elevator of the upper lip. Accompanying the artery is the facial vein, which takes nearly a straight course, and lies to its outer side.

plan of the branches. BRANCHES. From the outer side of the vessel unnamed branches are furnished to the muscles and integuments, some of which

anastomose with the transverse facial branch of the superficial temporal artery. From the inner side are given the following branches :—

The *inferior labial branch* (*t*) runs inwards beneath the depressor anguli oris muscle, and is distributed between the lower lip and chin ; it communicates with the inferior coronary, and with the mental branch of the inferior dental artery. Inferior labial.

Coronary branches (*r* and *s*). These are one for each lip (*superior* and *inferior*), which arise together or separately from the facial, and are directed inwards between the orbicular muscle and the mucous membrane of the lip to inosculate with the corresponding branches of the opposite side. From the arterial arches thus formed offsets are supplied to the structures of the lip. From the arch in the upper lip a branch is given to each side of the septum narium,—*artery of the septum.* Two coronary form an arch in each lip: branch to septum.

The *lateral nasal branch* (*p*) arises opposite the ala nasi, and passes beneath the levator labii superioris alæque nasi to the side of the nose, where it anastomoses with the nasal branch of the ophthalmic artery. Lateral nasal branch.

The *angular branch* (*o*) is the terminal twig of the facial artery at the inner angle of the orbit, and joins the nasal branch of the ophthalmic artery. Angular branch

The FACIAL VEIN commences at the root of the nose in a vein named the *angular*. It then crosses over the elevator of the upper lip, and, separating from the artery, courses beneath the large zygomatic muscle to the side of the jaw. Afterwards it has a short course in the neck to join the internal jugular vein. Facial vein away from artery;

Tributaries. At the inner side of the orbit the angular vein receives veins from the upper eyelid (*superior palpebral*) and from the side of the nose. Below the orbit it is joined by veins from the lower eyelid (*inferior palpebral*), as well as by a large branch, *anterior internal maxillary or deep facial vein*, that comes from a plexus in the pterygoid region, and thence on to its termination by veins corresponding with the branches of the artery in the face and neck. joined by branches.

The TRANSVERSE FACIAL ARTERY (fig. 204) is a branch of the superficial temporal, and appears on the face at the anterior border of the parotid gland. It lies by the side of the parotid duct, with branches of the facial nerve, and distributes offsets to the muscles and integuments ; some branches anastomose with the facial artery. Transverse facial artery.

Dissection. The parotid gland in front of the ear may be next displayed. A strong fascia covers the gland, and is connected above to the zygomatic arch and behind to the cartilage of the ear, but is continued in front over the masseter muscle. The fascia is to be removed, so that the gland may be detached slightly from the parts around. The great auricular nerve will be seen ascending to the lobule of the ear ; and three or four small lymphatic glands rest on the surface of the gland. Lay bare the parotid gland. Parotid fascia. Parotid lymphatic glands.

The PAROTID fig. 213, [10], p. 589) is the largest of the salivary glands. It occupies the space between the ear and the lower jaw, Parotid gland:

and is named from its position. Its excretory duct enters the mouth through the middle of the cheek.

irregular in shape; The shape of the gland is irregular, and is determined by the surrounding parts. Thus below, where there is not any resisting structure, the parotid projects into the neck, and comes into close proximity with the submaxillary gland, though separated from it by

relations; a process of the cervical fascia; a horizontal line from the angle of the jaw to the sterno-mastoid muscle usually marks the extent of the gland in this direction. Superiorly, the parotid is limited by the zygomatic arch and the temporal bone. Along the posterior part the sterno-mastoid muscle extends; but anteriorly, the gland projects somewhat into the face over the masseter muscle, and has connected

accessory part. with it in this situation a small accessory part, known as the *socia parotidis*.

The duct reaches mouth: Issuing from the anterior border is the excretory duct—*duct of Stenson* (fig. 204), which crosses the masseter below the socia parotidis, and perforates the buccinator and the mucous membrane of the cheek obliquely opposite the second molar tooth of the upper jaw. The duct lies between the transverse facial artery and some branches of the facial nerve, the latter being below it. A line drawn from the meatus auditorius to a little

surface marking, below the nostril would mark the level of the duct on the face; and the central point of the line would be opposite the opening

its length and size. into the mouth. The length of the duct is about two inches and a half; and its capacity is large enough to allow a small probe to pass, but the opening into the mouth is much less.

Surface of gland. The cutaneous surface of the parotid is smooth, and three or four lymphatic glands are seated on it: but from the deep part processes are sent into the inequalities of the space between the jaw and the mastoid process.

Dissection to see deep parts. **Dissection.** By removing the parotid gland, cautiously and piecemeal, from behind and below, the hollows that it fills will come into view: at the same time the dissector will see the vessels and nerves that pass through it. An examination of the processes of the gland, and of the number of important vessels and nerves in relation with it, will demonstrate the dangers attending any operation on it. The duct may be opened, and a pin may be passed along it to the mouth, to show the position and the diminished size of the aperture.

Deep part sinks behind jaw. Two large processes of the gland extend deeply into the neck. One dips behind the styloid process, and projects beneath the mastoid process and sterno-mastoid muscle, where it reaches the deep vessels and nerves of the neck. The other piece is situate in front of the styloid process; it passes into the glenoid hollow behind the articulation of the lower jaw, and sinks beneath the ramus of that bone along the internal maxillary artery.

Vessels and Coursing through the middle of the gland is the *external carotid artery*, which ascends behind the ramus of the jaw, and furnishes the posterior auricular, superficial temporal, and internal maxillary branches. Superficially to the artery lies the trunk formed by the

junction of the *temporal and internal maxillary veins;* and this common trunk, receiving some veins from the parotid, divides near the angle of the jaw into two branches, the *anterior* of which passes downwards to join the facial vein, while the *posterior* inclines backwards over the border of the sterno-mastoid muscle and is continued into the external jugular vein (fig. 211, p. 582). Crossing the vessels in the gland from behind forwards is the trunk of the *facial nerve*, which divides here into its primary branches. The superficial temporal branch of the inferior maxillary nerve lies above the upper part of the glandular mass; and offsets of the great auricular nerve pierce the gland at the lower part, and join the facial.

nerves in the gland.

In dissecting out the gland it has been seen to consist of a number of lobules separated by connective tissue septa. From the lobules small ducts arise, and these join together so as to give rise to two large tubes, which are placed superficially to the branches of the facial nerve in the gland, and by their union opposite the hinder margin of the ramus of the jaw form the beginning of Stenson's duct. As it crosses the masseter the main duct receives one or more small branches from the socia parotidis.

Obvious structure of gland.

The parotid receives its *arteries* from the external carotid; and its *nerves* from the sympathetic, auriculo-temporal of the fifth, and facial. Its *lymphatics* join those of the neck.

Vessels and nerves.

Two or three small *molar glands* lie on the surface of the buccinator, and open into the mouth near the last molar teeth by separate ducts.

Molar glands.

The FACIAL NERVE (fig. 205, p. 562), or the seventh cranial nerve, is the motor nerve of the superficial muscles of the head and face. Numerous communications take place between it and the fifth nerve; the chief of these are found above and below the orbit, and over the side of the lower jaw.

Outline of facial nerve.

Dissection. The trunk of the nerve is concealed by the parotid gland, but its ramifications are mostly in front of the glandular mass, and will be displayed in the removal of the gland.

Dissection of nerve

The different branches are to be traced forwards as they escape from beneath the anterior border of the gland and followed to their termination.

beyond parotid,

The highest branches to the temple have already been partly dissected above the zygomatic arch; and their junction with the temporal branch of the superior maxillary, and with the supra-orbital nerve has been seen. Some still smaller branches are to be traced to the outer part of the orbit, where they enter the eyelids and communicate with the other palpebral nerves; as these cross the malar bone, a junction is to be found with the subcutaneous malar branch of the fifth nerve.

on temple,

in eyelids,

With the duct of the parotid are two or more large branches, which are to be followed below the orbit to their junction with the infraorbital, nasal, and infratrochlear nerves.

in the face,

The remaining branches to the lower part of the face are smaller. One runs with the buccal nerve over the lower part of the buccinator muscle; and one or two others are to be traced

on lower jaw.

forwards to the lower lip, and to the mental branch of the inferior dental nerve.

The nerve in the parotid.

The trunk of the nerve should be followed backwards through

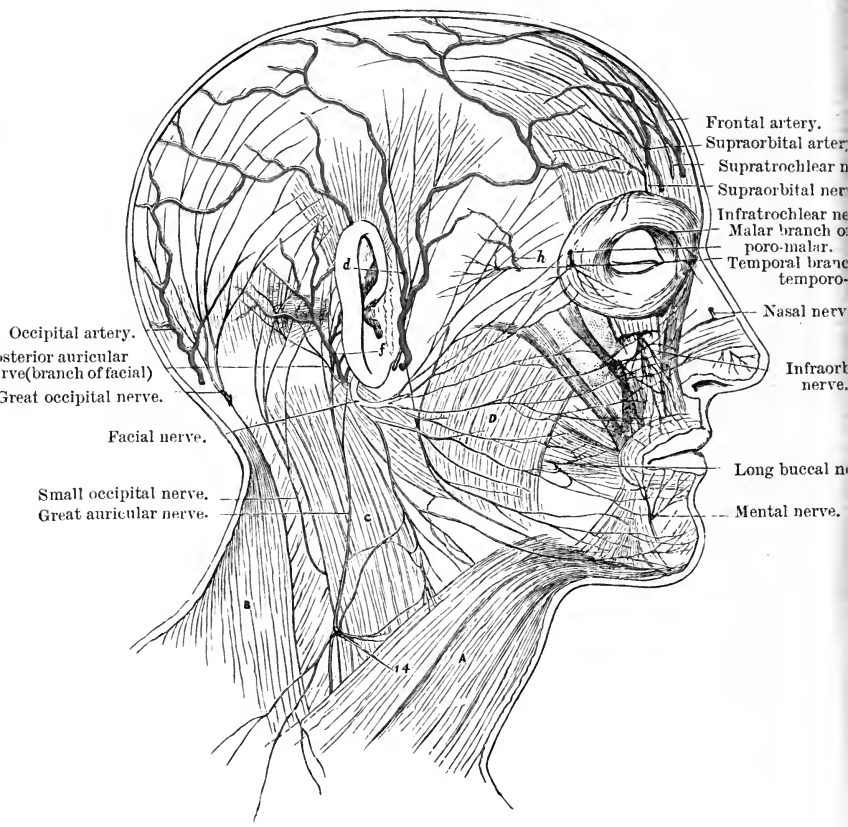


FIG. 205.—NERVES AND ARTERIES OF THE SCALP.

d. Superficial temporal artery.
f. Posterior auricular artery.
h. Orbital branch of superficial temporal artery.
14. The superficial cervical nerve.
A. Platysma muscle.
B. Trapezius muscle.
C. Sterno-mastoid muscle.
D. Masseter muscle.

The auriculo-temporal nerve is shown running up with the superficial temporal artery (*d*).

the gland, and in this proceeding its small branches of communication with the great auricular nerve, and, deeply, with the auriculo-temporal nerve (of the fifth) are to be sought for.

Lastly, the first small branches of the facial to the back of the ear and to the digastric and stylo-hyoid muscles are to be looked for close to the base of the skull just after the nerve emerges from the stylo-mastoid foramen. and muscular branches.

The FACIAL NERVE OUTSIDE THE SKULL (fig. 205). The nerve issues from the stylo-mastoid foramen, after traversing the aqueduct of Fallopius, and furnishes immediately the three following small branches :— Branches outside the skull.

The *posterior auricular branch* (fig. 205) turns upwards in front of the mastoid process, where it communicates with an offset of the great auricular, and is also joined by a branch to the ear from the pneumo-gastric nerve. It ends in an *occipital* branch to the occipitalis and an *auricular* branch to the retrahens muscle and to the small muscles on the back of the pinna. Posterior auricular branch.

The *branch to the digastric muscle* arises generally in common with the next. It is distributed by several offsets to the posterior belly of the muscle near the skull. Branch to digastric.

The *branch to the stylo-hyoid* is a long slender nerve, which is directed inwards, and enters the muscle about its middle. This branch communicates with the sympathetic nerve on the external carotid artery. Branch to stylo-hyoid.

As soon as the facial nerve has given off these branches, it is directed forwards through the gland, and divides near the ramus of the jaw into two large trunks—temporo-facial and cervico-facial. Division into two.

The TEMPORO-FACIAL TRUNK furnishes offsets to the side of the head and face which extend downwards to the level of the mouth. As this trunk crosses over the external carotid artery it receives one or two large branches from the auriculo-temporal portion of the inferior maxillary nerve, and then divides into three sets of terminal branches—temporal, malar, and infraorbital, which have frequent communications with one another as they pass forwards in the face. The upper division of the nerve has three sets of branches.

The *temporal branches* ascend obliquely over the zygomatic arch to enter the orbicularis palpebrarum, the corrugator supercilii and the frontalis muscles ; they are united with offsets of the supra-orbital nerve. The attrahens and attollens aurem muscles are supplied from this set ; and a junction takes place above the zygoma with the temporal branch of the superior maxillary nerve. Temporal branches to side of head.

The *malar branches* are directed to the outer side of the orbit, and are distributed to the orbicularis muscle. Communications take place in the eyelids with the palpebral filaments of the fifth nerve and over the malar bone with the small subcutaneous malar branch of the superior maxillary nerve. Malar branches to eyelids.

The *infraorbital branches* are larger than the rest, and are furnished to the muscles between the eye and mouth. Close to the orbit, and beneath the elevator of the upper lip, a free communication—*infraorbital plexus*, is formed between these nerves and the infraorbital branches of the superior maxillary. After crossing the branches of the fifth nerve, some small offsets of these branches pass inwards to the side of the nose, and others Infraorbital branches between eye and mouth.

upwards to the inner angle of the orbit to supply the muscles, and to join the nasal and infractrochlear branches of the ophthalmic nerve.

Lower division of the nerve has also three sets of branches.

The CERVICO-FACIAL is smaller than the upper trunk, and distributes nerves to the lower part of the face and the upper part of the neck. Its highest branches join the lowest offsets of the temporo-facial division, and thus complete the network on the face. This trunk, while in the parotid, gives twigs to the gland, and is united with the great auricular nerve. The terminal branches distributed from it are buccal, supramaxillary, and inframaxillary.

Buccal to corner of mouth.

The *buccal branches* pass forwards towards the angle of the mouth, giving offsets to the buccinator muscle, and terminate in the orbicularis oris. On the buccinator they join the buccal branch of the inferior maxillary nerve.

Supra-maxillary between mouth and chin.

The *supramaxillary branches* course forwards over the lower jaw to the middle line, and supply the muscles of the lower lip and chin. Beneath the depressor anguli oris these branches of the facial join the offsets of the mental branch of the inferior dental nerve.

Infra-maxillary to neck.

The *inframaxillary branch* lies below the jaw, and is distributed to the platysma muscle, and forms communication with sensory branches from the second and third cervical nerves.

Dissection. The levater labii superioris muscle is now to be cut through, and the upper part removed so as to expose the terminal branches of the *infraorbital* nerve.

Infra-orbital nerve.

The INFRAORBITAL NERVE (fig. 205) is the continuation of the superior maxillary division of the fifth nerve. It emerges on the face through the infraorbital foramen under cover of the levator labii superioris, and at once divides into terminal branches which radiate to the eyelid, the nose, and the upper lip.

Palpebral,

The *palpebral branches* are usually two small twigs which pass to the lower eyelid.

lateral nasal and

The *lateral nasal branches* are directed inwards, and supply the skin of the side of the nose.

labial branches.

The *labial branches* are three or four larger nerves, which, descending to the upper lip, supplying the skin of the face between the orbit and the mouth, as well as the mucous membrane of the upper lip, and their ramifications, take part in the *infraorbital plexus*, just described.

Dissection. The depressor labii inferioris and anguli oris muscles will next be removed so as to expose the *mental nerve* as it issues from the foramen in the lower jaw.

Mental nerve.

The MENTAL NERVE (fig. 205) is derived from the inferior dental nerve within the lower jaw, and issues through the mental foramen beneath the depressor anguli oris muscle. It gives an offset downwards to the skin of the chin, but the greater part of the nerve ascends beneath the depressor labii inferioris muscle, to be distributed to the inner and outer surfaces of the lower lip. Its branches communicate with the supramaxillary branches of the facial nerve.

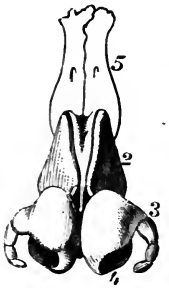
EXTERNAL PARTS OF THE NOSE.

Directions. The external parts of the nose, the appendages of the eye, and the pinna will now be cleaned and examined.

The Nose has the form of a three-sided pyramid, which is attached to the face by one of its surfaces, while the base is free. The lateral surfaces meet anteriorly in a rounded edge termed the *dorsum*, the upper part of which is known also as the *bridge*. The lower and posterior part of each lateral surface is convex and marked off by a curved groove, constituting the *ala*. The base presents the oval apertures of the *nostrils* or *anterior nares*, separated by a short thick partition, the *septum narium* or *columna nasi*. External nose: its parts,

The shape of the nose is maintained by a framework consisting of the nasal bones and the nasal processes of the superior maxillary bones above, and of the cartilages of the nose below, in the part corresponding to the anterior nasal aperture of the skull. and frame work.

Cartilages of the Nose (fig. 206). These are five in number, one in the centre, the *cartilage of the septum*, and two on each side, the *lateral cartilage* and the *cartilage of the aperture*. They are all hyaline cartilage, but do not show any tendency to become ossified. Only the lateral cartilages are learnt in this stage of the dissection.



Nasal cartilages.

Fig. 206.—Cartilages of the Nose.

1. Septal cartilage.
2. Lateral cartilage.
3. Cartilages of the aperature, its outer part, and 4, its inner part.
5. Nasal bone.

Dissection. The lateral cartilages will be seen when the muscular and fibrous structures of the left side of the nose have been taken away. By turning aside the lateral cartilages the septal one will appear in the middle line. Take away tissue from surface.

The *lateral cartilage* (upper lat. cart. fig. 206, [2]) is flattened, and triangular in form. Posteriorly it is attached to the nasal and upper maxillary bones; and anteriorly it joins the cartilage of the septum above, but is separated from it by a narrow cleft below. Inferiorly, the lateral cartilage is contiguous to the cartilage of the aperture, and is connected to it by fibrous tissue. The upper cartilage joins the septal.

The *cartilage of the aperture* (lower lat. cart.; fig. 206) forms a ring around the opening of the nose except behind. It has not any attachment directly to bone; but it is united above to the lateral cartilage by fibrous tissue, and below with the dense teguments forming the ala of the nose and the margin of the nostril. The lower surrounds aperture; not inserted into bone.

The part of the cartilage ([3]) which bounds the opening externally is narrow and pointed behind, where it forms two or three vertical folds, and sometimes becomes divided into as many small pieces—*cartilagines quadratæ;* but it swells out in front where it touches its fellow, and forms the apex of the nose. One part outside; accessory cartilages;

The inner part ([4]) is shorter and narrower. It projects backwards another inside nostril.

in the columna nasi below the level of the anterior end of the septal cartilage, being attached to this and to its fellow of the opposite side by fibrous tissue, and reaches nearly to the superior maxillary bone.

THE APPENDAGES OF THE EYE.

Appendages of the eye.

The Appendages of the Eye include the eyebrow, the eyelid, and the lachrymal apparatus.

Eyebrow.

The *eyebrow* (supercilium) is a curved eminence just above the eye which is placed over the orbital arch of the frontal bone. It consists of thickened integuments, and its prominence is in part due to the subjacent orbicularis palpebrarum and corrugator supercilii muscles. It is furnished with long coarse hairs, which are directed outwards, and towards one another.

Eyelids.

The *eyelids* (palpebræ) are two movable semilunar folds in front of the eye, which can be approached or separated over the eyeball.

Upper larger.

The upper lid is the larger and more moveable, and descends below the middle of the eyeball when the two meet; it is also provided with a special muscle to raise it. The interval between the open lids is named the *palpebral fissure*. Externally and internally they are united by a commissure or *canthus*.

Shape of margin.

The free border of each lid is somewhat thickened, and presents a narrow surface which meets the opposite lid when the aperture is closed, and is bounded towards the eyeball by a sharp smooth edge; but at the inner end, for about a quarter of an inch from the commissure, it is somewhat thinner and more rounded. At the

Papilla.

spot where the two parts join is a small white eminence (fig. 207),

Punctum.

the *papilla lachrymalis;* and in this is the *punctum lachrymale*, or the opening of the canal for the tears.

Hairs and apertures.

This margin is provided anteriorly with the eyelashes, and near the posterior edge with a row of small openings of the Meibomian glands; but both the cilia and the glands are absent from the part of the lid which is internal to the opening of the punctum lachrymale.

Eyelashes.

The *eyelashes* (cilia) are two or more rows of curved hairs, which are fixed into the anterior edge of the free border of the lid; they are largest in the upper lid, and diminish in length from the centre to the sides. The cilia of the two lids are convex to one another, and cross when the lids are shut.

Apparatus for the tears.

Lachrymal Apparatus (fig. 207). The lachrymal gland, puncta, canals, and sac, with the nasal duct, constitute the apparatus by which the tears are formed and conveyed to the nose.

Dissection.

Dissection. A bristle or blunted pin should be introduced into each lachrymal canal through the punctum. The lachrymal sac will appear on the removal of the internal tarsal ligament and of the areolar tissue from its surface as it lies on the lachrymal bone. The prolongation from the internal tarsal ligament over the sac should be defined and understood before its removal (p. 568).

Apertures in eyelids.

The *puncta lachrymalia* (1), one on each lid, are the openings of the lachrymal canals. Each is situate on the free margin of the lid, about a quarter of an inch from the inner canthus, and at the summit of the papilla lachrymalis.

The *lachrymal canals* (canaliculi; fig. 207, [2] and [3]) lead from the puncta, and convey the tears to the lachrymal sac. From the margin of the lid, each canal is directed vertically for about one-sixteenth of an inch, and then bends inwards following the course of the internal tarsal ligament. Internally the two canals converge, and they open into the lachrymal sac, rather above its middle, either separately or by a common orifice. Canals for the tears.

The *lachrymal sac* and *nasal duct* extends from the inner side of the orbit to the nose, and convey the tears into the latter cavity. They form one tube, of which the upper dilated end is the sac, and the lower part the duct. Receptacle of the tears.

The *sac* ([5]) is placed in the hollow formed by the nasal process of the superior maxillary and the lachrymal bones. In front, it is crossed by the internal tarsal ligament of the eyelids; and behind, it is covered by an expansion derived from that band, which is fixed to the lachrymal crest. If the aponeurotic covering be removed, the mucous lining will appear. Into the outer side of the sac the lachrymal canals open. Situation of the sac, or dilated part.

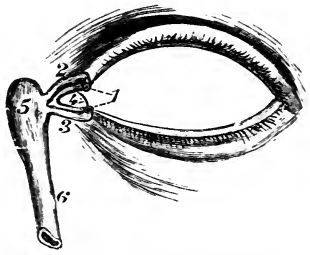


Fig. 207.—The Eyelids and Lachrymal Apparatus.

1. Puncta lachrymalia.
2. Upper, and 3, lower lachrymal canal.
4. Caruncula lachrymalis.
5. Lachrymal sac.
6. Nasal duct.

The *duct* ([6]) is the narrower part of the tube, and is about half an inch long. It is entirely surrounded by bone, and inclines slightly outwards and backwards as it descends. In the nasal cavity it opens into the fore part of the inferior meatus, where its opening is guarded by a small fold of the mucous membrane. Canal leading to the nose: its opening.

Within the bone, the duct has a fibrous coat lined by mucous membrane, which is continuous with that of the nose below, and, through the canals, with the conjunctiva above. Structure of the duct.

Structure of the Eyelids. Each lid consists fundamentally of a fibrous plate attached to the bone by ligaments. Superficial to this framework are the integuments with a layer of fibres of the orbicularis palpebrarum, and beneath it the mucous lining of the conjunctiva. The upper lid includes also the tendon of the levator palpebræ. Vessels and nerves are contained in the lids. Different parts in eyelids.

Dissection. The student should now examine the structure of the lids. The bit of tow or wool may remain beneath the lids; and the palpebral part of the orbicularis muscle is to be thrown inwards by an incision around the margin of the orbit. In raising the muscle care must be taken of the thin membranous *palpebral fascia* beneath, and of the vessels and nerves of the lid. Dissect lids.

Orbicularis palpebrarum. The palpebral fibres of this muscle form a pale layer which reaches the free edge of the eyelids, and a thin stratum of areolar tissue without fat unites the muscle with the skin. Layer of orbicularis.

A fibrous layer.

The *palpebral fascia* is a thin fibrous layer, which is continued from the margin of the orbit to join the anterior surface of the fibrous tarsal plate. At the inner part of the orbit it is thin and loose, but at the outer part it is somewhat thicker and stronger.

A fibrous plate forms part of the lid:

The *fibrous plates* (tarsi), one for each eyelid, are elongated transversely, and give strength to the lids. Each is fixed internally and externally by fibrous bands—the *tarsal* or *palpebral ligaments*, to the margin of the orbit. The border corresponding with the edge of the lid is free, and thicker than the rest of the plate. On the deep surface each tarsus is lined by the conjunctiva.

difference in the two lids.

The tarsi are not alike in the two lids. In the upper eyelid, where the fibrous plate is larger, it is crescentic in shape, and is nearly half an inch wide in the centre; and to its fore part the tendon of the levator palpebræ is attached. In the lower lid the tarsus is a narrow band, about one-sixth of an inch broad, with nearly straight borders.

Ligaments of eyelids attach tarsal plates.

The *internal tarsal ligament* (tendo palpebrarum) is a small fibrous band at the inner side of the orbit, which serves to fix the lids, and is attached to the anterior margin of the lachrymal groove in the upper jaw. It is about a quarter of an inch long, and divides into two processes, which are united with the tarsal plates, one to each. This ligament crosses the lachrymal sac, behind which it sends a fibrous expansion; and the fleshy fibres of the orbicularis palpebrarum arise from it. The *external tarsal ligament* is a much weaker band uniting the tarsi to the malar bone.

Sebaceous tubes in lid:

The *Meibomian* or *tarsal glands* are embedded in the substance of the tarsal plates, and can be readily seen through the conjunctiva on the posterior surface of the lids. They extend, parallel to one another, from the free towards the opposite margin of the tarsus; and their number is about thirty in the upper, and twenty in the lower lid. The apertures of the glands open in a line at the free border of the lid near the posterior edge.

their structure.

Each gland is a small yellowish tube, closed at one end, and having minute lateral cæcal appendages connected with it. The secretion is similar to that of the sebaceous glands of the skin.

Tendon of levator palpebræ.

If the palpebral fascia be cut through in the upper lid, the *tendon* of the *levator palpebræ* will be seen to be inserted into the fore part of the tarsus by a wide aponeurotic expansion.

Mucous lining of lid.

The *conjunctiva*, or mucous membrane, lines the interior of the lids, from which it is reflected to the front of the eyeball. The line of reflection is known as the *fornix conjunctivæ*, and is placed, above and below, some distance beyond the convex margin of the tarsus. Inside the lids the conjunctiva is inseparably united to the tarsi, and has numerous fine papillæ. At the free margin of the lids it joins the skin, and through the lachrymal canals and nasal duct it is continuous with the pituitary membrane of the nose.

Caruncle

Between the eyeball and the inner commissure of the lids is seen a prominent and fleshy-looking body—*caruncula lachrymalis* (fig. 207, 4), which contains a group of glands, and has a few minute hairs on its surface. External to the caruncle is a small

vertical fold of the mucous membrane—*plica semilunaris*, resting on the inner part of the eyeball. and contiguous fold.

Blood-vessels of the eyelids. The *arteries* of the eyelids are furnished by the palpebral aud lachrymal branches of the ophthalmic artery :— Arteries of lids :

The *palpebral arteries*, one for each eyelid, run outwards from the inner canthus, lying between the tarsal plate and the orbicular muscle, and anastomose externally with the lachrymal artery. From each arch branches are distributed to the structures of the lid. palpebral

The terminal portion of the *lachrymal artery* perforates the palpebral fascia at the outer part of the orbit, and, after having given small offsets to the upper eyelid, divides into two branches which complete the palpebral arches. and lachrymal.

The *veins* of the lids open into the angular, facial and temporal veins. Veins.

The *nerves* of the eyelids are supplied from the ophthalmic and superior maxillary divisions of the fifth and the facial nerves. Nerves of lids,

The branches of the ophthalmic nerve which give offsets to the upper lid are the following : *lachrymal*, at the outer part ; *supra-orbital*, about the middle ; and *supratrochlear* and *infratrochlear* at the inner side. In the lower eyelid there are usually two *palpebral branches*, inner and outer, of the infra-orbital branch of the *superior maxillary nerve*. from fifth,

Branches of the *facial nerve* enter both lids at the outer side, and supply the orbicularis muscle ; they communicate with the offsets of the fifth nerve. and seventh nerve.

THE EXTERNAL EAR.

External Ear. The outer ear consists of a broad, projecting part, named the pinna or auricle, and of a tube—meatus auditorius externus, leading inwards to the middle ear, from which it is separated by the tympanic membrane. The pinna may be now examined, but the meatus will be described with the anatomy of the ear. Parts of external ear.

The pinna or auricle (fig. 208) is an uneven piece of yellow fibro-cartilage, which is covered with integument, and is fixed to the margin of the meatus auditorius externus. It is of a somewhat oval form, with the margin folded and the upper end larger than the lower. Texture and form of pinna.

The surface next the head is generally convex ; and the opposite excavated, but presenting the following elevations and depressions. In the centre is a deep hollow named the *concha*, which is wide above but narrow below ; it conducts to the meatus auditorius. In front of the narrowed part of the hollow is a projection of a triangular shape—the *tragus*, which has some hairs on the inner surface ; and on the opposite side of the same narrow end, rather below the level of the tragus, is placed another projection—the *antitragus*. Surface marked by fossæ and eminences.

The prominent rim-like margin of the ear, which extends into the concha, is called the *helix ;* and the depression internal to it is the *groove* or *fossa of the helix*. Within the helix, forming the hinder and upper boundary of the concha, is the large eminence of the *antihelix*, which presents at its upper and fore-part a triangular depression, the *fossa of the antihelix*. Margin.

Lobule. Inferiorly the auricle ends in a soft pendulous part, the *lobule.*

Intrinsic muscles of auricle. The *special muscles of the pinna*, which extend from one part of the cartilage to another, are very thin and pale. Five small muscles are to be recognised; and these receive their names for the most part from the several eminences of the external ear.

How to find the muscles. **Dissection.** In seeking the small auricular muscles, let the skin be removed only over the spot where each muscle is said to be placed. A sharp knife and a good light are necessary for the display of the muscular fibres. Occasionally the dissector will not find one or more of the number described below.

One muscle on tragus. The *muscle of the tragus* (fig. 208,[1]) is always found on the external aspect of the process from which it takes its name. The

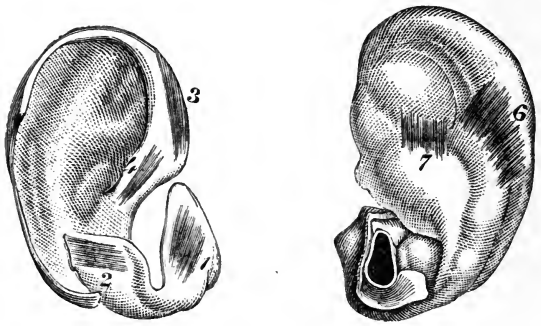


Fig. 208.

Muscles of the Outer Surface of the Ear-cartilage.

1. Muscle of the tragus.
2. Muscle of the antitragus.
3. Large muscle of the helix.
4. Small muscle of the helix.

Muscles on the Inner Surface of the Ear-cartilage.

6. Transverse muscle.
7. Oblique muscle sometimes seen.

fibres are short, oblique, and extend from the outer to the inner part of the tragus.

One on antitragus. The *muscle of the antitragus* (fig. 208, [2]) is the best marked of all. It *arises* from the outer part of the antitragus, and the fibres are directed upwards to be *inserted* into the pointed extremity of the antihelix.

One on root of helix. The *small muscle of the helix* (fig. 208, [4]) is often indistinct or absent. It is placed on the part of the rim of the ear that extends into the concha.

Another on helix. The *large muscle of the helix* (fig. 208,[3]) *arises* above the small muscle of the same part, and is *inserted* into the front of the helix, where this is about to curve backwards. It is usually present.

And one at back of concha. The *transverse muscle of the auricle* (fig. 208, [6]) forms a wide layer which is situate at the back of the ear in the depression between the helix and the convexity of the concha. It *arises* from the convexity of the cartilage forming the concha, and is *inserted* into the

back of the helix. The muscle is mixed with much fibrous tissue, but it is well seen when that tissue is removed.

Dissection. The remaining skin should now be removed from the pinna, and the muscles cleaned off to expose the cartilage: in doing this the lobule of the ear, which consists only of skin and fat, will disappear as in fig. 208. Clean the cartilage.

The *cartilage of the pinna* (fig. 208) resembles much the external ear in form, and presents nearly the same parts. The rim of the helix subsides posteriorly about the middle of the pinna: while anteriorly a small process projects from it, and there is a fissure near the projection. The part of the cartilage forming the fossa of the helix ends on a level with the lowest part of the concha in a pointed process which is separated from the antitragus by a deep notch. The antihelix is continued below into the antitragus. On the posterior aspect of the concha is a strong vertical ridge of cartilage. Cartilage forms part of external ear: deficient below,

Inferiorly the cartilage is fixed to the margin of the external auditory aperture in the temporal bone, and forms a portion of the meatus auditorius; but it does not give rise to a complete tube, for at the upper and hinder part that canal is closed by fibrous tissue. and at upper part of meatus;

In the piece of cartilage forming the outer end of the meatus are two *fissures* (of Santorini): one is directed vertically beneath the base of the tragus; the other passes from before backwards in the floor of the meatus. its fissures.

Some *ligaments* connect the pinna with the head, and others pass from one point to another of the cartilage. Ligaments;

The *external* ligaments are two bands of fibrous tissue, anterior and posterior. The anterior fixes the fore part of the helix to the root of the zygoma. The posterior passes from the back of the concha to the mastoid process. The chief *special* ligament crosses the interval between the tragus and the helix, and completes the opening of the auditory meatus. extrinsic, intrinsic.

Vessels and nerves of the auricle. The *arteries* of the auricle are derived from the *superficial temporal* (*ant. auricular branches*) and the *posterior auricular* branches of the external carotid. The *veins* have a corresponding termination. The skin of the pinna is supplied on the outer surface mainly by the *auricular-temporal* branch of the inferior maxillary nerve, on the inner surface in the upper part by the *small occipital*, and in the lower part, together with the outer aspect of the lobule, by the *great auricular nerve*. The *auricular branch of the vagus* also reaches the back of the concha. The muscles are supplied by the *posterior auricular* branch of the facial nerve.

Section VI.

DISSECTION OF THE NECK.

Position. For the dissection of this part, the neck is supported on a block of a moderate height, the chin drawn up so as to put the parts on the stretch and the shoulder depressed as much as the work that is being done on the axilla will allow, and the face should be turned to the opposite side.

Boundaries of the side of the neck.

Surface Marking. The side of the neck has a somewhat irregularly quadrilateral outline, and is limited in the following way :—Below is the prominence of the clavicle ; and above is the base of the lower jaw with the skull. In front, the boundary is the middle line of the neck between the chin and sternum ; and behind, a line from the occiput to the acromial end of the clavicle. The part thus included is divided into two triangular spaces (*anterior* and *posterior*) by the diagonal prominence of the sterno-mastoid muscle (fig. 209). And in consequence of the position of that muscle the base of the anterior triangle is at the jaw, and the apex at the sternum ; while the base of the posterior one is at the clavicle, and the apex at the head.

Division into two triangles by sterno-mastoid.

Hollows.

The surface in front of the sterno-mastoid is depressed at the upper part of the neck, near the position of the carotid vessels ; and behind the muscle, just above the clavicle, is another hollow, the *supraclavicular fossa*, which indicates the position of the subclavian artery.

Objects in middle line of neck :

Along the front of the neck the following parts can be recognised through the skin :—About two inches and a half from the chin, in the retiring angle formed by the outline of the front of the neck,

hyoid bone,

the body of the hyoid bone may be felt, with its large cornu extending backwards on each side. Below this is the prominence of

thyroid cartilage,

the thyroid cartilage, called *pomum Adami*, which is more marked in the male sex ; and between the cartilage and the hyoid bone is a

thyro-hyoid interval,

slight interval, corresponding with the thyro-hyoid membrane.

Below the thyroid is the narrow prominent ring of the cricoid

cricoid cartilage,

cartilage ; and between the two the finger may distinguish another

crico-thyroid interval,

interval, which is opposite the crico-thyroid membrane.

Immediately above the sternum, and bounded on each side by the prominent sterno-mastoid muscle, is a narrow depression—*supra-sternal fossa*, the depth of which is much increased in emaciated persons, and in it the tube of the trachea can be recognised. In some bodies, especially in women, the swelling of the thyroid gland may be felt by the side of the air-tube.

and supra-sternal depression.

Direction. As it is necessary for the liberation of the upper limb to have an early dissection of the posterior part of the neck, the student should lay bare now only the part behind the sterno-mastoid muscle.

Dissection of the platysma.

Dissection. To raise the skin from the posterior triangle of the neck, make an incision along the sterno-mastoid muscle from the tip of the mastoid process to the clavicle one inch external to its

articulation with the sternum; from the lower end of this make another cut outwards along the clavicle as far as the acromion and reflect the piece of skin backwards towards the trapezius muscle. The superficial fascia, which will then be brought into view, contains the platysma; and to see that muscle, it will be necessary to take the subcutaneous layer from the surface of the fibres.

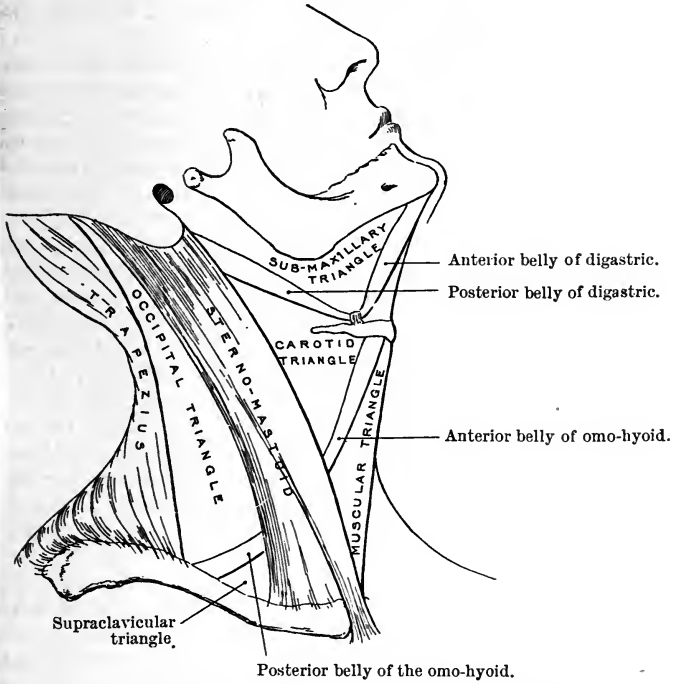


FIG. 209.—DIAGRAM OF THE TRIANGLES OF THE NECK.

The ANTERIOR TRIANGLE is made up of—

1. The sub-maxillary triangle.
2. The carotid triangle.
3. The muscular triangle.

The POSTERIOR TRIANGLE is made up of—

1. The occipital triangle.
2. The supraclavicular triangle.

The PLATYSMA MYOIDES is a thin subcutaneous muscular layer, which is now seen only in its posterior half. It is placed across the side of the neck, and extends from the shoulder to the face. Its fleshy fibres take *origin* from the skin and subcutaneous tissue over the clavicle and acromion, as well as from that covering the highest parts of the pectoral and deltoid muscles; ascending through the neck, the fibres are *inserted* into the jaw and the angle of the mouth.

Platysma muscle

arises at shoulder;

inserted into jaw

covers triangle ; The lower part of the muscle is more closely united to the skin than the upper, and covers the external jugular vein as well as the lower part of the posterior triangle. At first the fibres of the muscle are thin and scattered, but they increase in strength as they ascend. The oblique direction of the fibres should be noted, because in venesection in the external jugular vein the incision is to be so made as to divide them transversely.

use. The action will be found with the description of the remainder of the muscle (p. 579).

Dissection. **Dissection.** The platysma is to be cut across near the clavicle, and to be reflected forwards as far as the incision over the sterno-mastoid muscle, but it is to be left attached at that spot. In raising the muscle the student must be careful of the deep fascia of the neck, and of the external jugular vein, with the superficial descending branches of the cervical plexus, which are close beneath the platysma, and which he should dissect out.

External jugular vein The EXTERNAL JUGULAR VEIN (fig. 210,[8] p. 576) begins just behind the angle of the jaw by the union of the posterior division of the temporo-maxillary with the posterior articular vein (fig. 211, p. 582). Descending beneath the platysma to the lower part of the neck, it there pierces the deep cervical fascia to open into the subclavian vein. Its course down the neck will be marked by a line from the angle of the jaw to the middle of the clavicle. Beyond the sterno-mastoid muscle the vein is dilated, and the swollen part (*sinus*) is limited by two pairs of valves,—one being situate below at the mouth of the vein, and the other near the muscle. Small superficial branches join the vein, and an offset connects it with the anterior jugular vein. Its size and the height at which it crosses the sterno-mastoid muscle, are very uncertain.

crosses side of neck to subclavian.

Cervical fascia. The DEEP CERVICAL FASCIA, like the aponeuroses in other regions of the body, consists of a superficial layer which surrounds the neck continuously, and of processes that are prolonged inwards between the muscles. In some bodies this fascia is thin and indistinct.

In its extent round the neck the membrane encases the sterno-mastoid, and has a different disposition before and behind that muscle. As now seen passing backwards from the muscle, the fascia continues over the posterior triangular space, and encloses the trapezius in its progress to the spines of the vertebræ. At the lower part of the neck it is attached to the clavicle, and is perforated by the external jugular vein and the cutaneous nerves.

Part behind sterno-mastoid muscle

sends a process around omo-hyoid. After the superficial layer has been removed near the clavicle, a deep process may be observed surrounding the omo-hyoid muscle, and passing downwards behind the clavicle, to be fixed at the back of that bone, and the anterior end of the first rib.

POSTERIOR TRIANGULAR SPACE.

Posterior triangular space of the neck. This space (fig. 210), having the form and position before noted is about eight inches in length. It contains the cervical and brachial

plexuses, with the portion of the subclavian artery and some offsets of the vessel and the nerves.

Dissection. By the removal of the cervical fascia and the fat between the sterno-mastoid and trapezius muscles, the posterior triangle of the neck will be displayed. In the execution of this somewhat difficult task the student should proceed cautiously, to avoid injuring the numerous nerves and vessels in the space. Dissection of the space.

Seek first the small omo-hyoid muscle (fig 210 [3]), which crosses the space obliquely about an inch above the clavicle, and divides it into two smaller triangles, *occipital* and *supra clavicular* (fig. 209). Close to or beneath the upper border of the muscle lie the slender nerve and vessels to it: the nerve is derived from the ansa hypoglossi, and the artery from the suprascapular. Find omo-hyoid.

Above the omo-hyoid muscle will be found the branches of the cervical plexus, together with the spinal accessory nerve; the latter will be recognised by its piercing the sterno-mastoid muscle. The greater number of the branches of the cervical plexus descend to the shoulder; but the small occipital and great auricular nerves ascend to the head, and the superficial cervical branch is directed forwards over the sterno-mastoid muscle. Nerves above omo-hyoid;

Below the omo-hyoid find the large subclavian artery and the brachial plexus, which have a deep position, and run downwards and outwards. Also the following vessels and nerve are to be further cleaned, viz., the suprascapular vessels behind the clavicle; the transverse cervical vessel, which is higher in the neck, taking an outward direction beneath the omo-hyoid muscle; and, lastly, the small branch of nerve to the subclavius muscle, which lies about the middle of the space between the clavicle and the omo-hyoid. vessels below, and a small nerve.

Underneath the trapezius, where it is attached to the clavicle, define the uppermost digitation of the serratus magnus muscle; and behind the brachial plexus, towards the lower part of the space, the middle scalenus muscle appears. Through the scalenus issue two muscular nerves; one, the long thoracic, formed by two or three roots, for the serratus magnus; the other smaller, and higher up, for the rhomboidei. Define serratus, and nerves piercing scalenus.

Limits of the space. The space is bounded in front by the sterno-mastoid muscle (1), and behind by the trapezius (2). Its base corresponds with the middle third of the clavicle, and its apex is at the skull. In its floor are several muscles, which are placed in the following order from above downwards, viz., splenius capitis, levator, anguli scapulæ (6), and middle scalenus (5); and at the lower and outer angle, somewhat beneath the trapezius, lies the upper part of the serratus magnus. Covering the space are the structures already examined, viz., the skin and superficial fascia, the platysma over the lower half or two-thirds, and the deep fascia. Boundaries.

The small omo-hyoid muscle (3) crosses the space near the clavicle, so as to divide it into two, a lower or supraclavicular triangle, and an upper or occipital (fig. 209). Is divided by omo-hyoid.

The *supraclavicular triangle* is the smaller, and contains the sub-

clavian artery. It is bounded in front by the sterno-mastoid, above by the posterior belly of the omo-hyoid, and below by the clavicle.

FIG. 210.—PART OF THE POSTERIOR TRIANGLE OF THE NECK IS HERE DISPLAYED, BUT THE STUDENT SHOULD CARRY THE DISSECTION AS HIGH AS THE HEAD, SO AS TO LAY BARE THE WHOLE OF THAT SPACE.

1. Sterno-mastoid.
2. Trapezius.
3. Posterior belly of omo-hyoid.
4. Anterior scalenus, with the phrenic nerve on it, exposed by the shrinking of the sterno-mastoid.
5. Middle scalenus.
6. Levator anguli scapulæ.
7. Third part of subclavian artery.
8. External jugular vein joining the subclavian below.
9. Brachial plexus.
10. Spinal accessory nerve.

(Blandin's Surgical Anatomy.)

Extent of the space.

This space measures commonly about two inches from before backwards, and about one inch from above downwards at its base.

Trunks of vessels and nerves.

Crossing the area of this space, rather above the level of the clavicle, is the trunk of the subclavian artery (fig. 210, 7) which

issues from beneath the anterior scalenus muscle, and is directed over the first rib to the axilla. In the ordinary condition of the vessel the companion subclavian vein is seldom seen, owing to its being placed lower down behind the clavicle. Above the artery are the large cords of the brachial plexus (9), which accompany the vessel, and become closely applied to it beneath the clavicle. Behind the artery and the nerves is the middle scalenus muscle (5). And below the vessel is the first rib.

and their relative position.

Along the lower boundary of the space, and rather beneath the clavicle, lie the suprascapular vessels; and crossing the upper angle, at the meeting of the omo-hyoid and sterno-mastoid muscles, are the transverse cervical vessels. Entering the space from above is the external jugular vein (8), which descends over (seldom under) the omo-hyoid, and opens into the subclavian vein; in this region the vein receives the suprascapular and transverse cervical branches, and sometimes a small vein over the clavicle, from the cephalic vein of the arm.

Branches of vessels.

The length of this space depends mainly upon the extent of the attachment of the trapezius and sterno-mastoid muscles to the clavicle: in some bodies these muscles occupy nearly the whole length of that bone, leaving but a small interval between them; and occasionally they meet, so as to cover the subclavian artery altogether. The space also varies in height according to the position of the omo-hyoid, for this muscle sometimes lies close to, or even arises from the clavicle, while on the other hand, it may be distant one inch and a half from that bone.

Variations in the size of the space,

In depth the space varies naturally; and in a short thick neck with a prominent clavicle, the artery is farther from the surface than in the opposite condition of the parts. But the depth may be altered much more by change in the position of the clavicle, as the shoulder is carried forwards or backwards. And lastly, the artery may be concealed entirely in its usual position by forcing upwards the arm and shoulder, as the collar-bone can be raised above the level of the omo-hyoid muscle.

also in the depth, both natural and artificial.

The position of the subclavian artery itself is also subject to variation, for the vessel may be one inch and a half above the clavicle, or at any point intermediate between this and the bone; therefore the drawing down of the shoulder, so as to expose the vessel as much as possible, is an important preliminary in operations to reach the subclavian artery in this space. In the typical condition there is not any branch arising from the trunk in this part of its course; but the posterior scapular artery (fig. 210) is frequently given off beyond the scalenus anticus, and sometimes there is more than one branch.

Departure from the ordinary state of the artery, and its branches.

The subclavian vein occasionally rises upwards as high as the artery; or in some rare instances, it even lies with the artery beneath the anterior scalenus. The position of the external jugular vein with regard to the subclavian artery is very uncertain; and the branches connected with its lower end often form a kind of plexus over the arterial trunk.

Position of veins.

Occipital triangle

The *occipital triangle* is larger than the supraclavicular. Its boundaries in front and behind are the sterno-mastoid and the trapezius, and below the posterior belly of the omo-hyoid muscle.

contains nerves and lymphatics; also spinal accessory nerve.

In it are contained chiefly the ramifications of the cervical plexus; and a chain of lymphatic glands lies along the sterno-mastoid muscle. The spinal accessory nerve ([10]) is directed obliquely across this interval from the sterno-mastoid muscle, which it pierces, to the under surface of the trapezius; and a communication takes place between it and the spinal nerves in the space.

Nerves of the cervical plexus

Superficial Branches of the Cervical Plexus. These nerves emerge from beneath the sterno-mastoid muscle about the middle of its hinder border, and are thence directed both upwards and downwards.

that ascend, viz.—

The ascending set (fig. 210) are three in number, viz., small occipital, great auricular, and superficial cervical.

Small occipital.

The *small occipital nerve* (fig. 205, p. 562) comes from the second, and in most cases also from the third cervical nerves, and is directed upwards to the head along the posterior border of the sterno-mastoid muscle. It perforates the fascia near the skull, and is distributed between the ear and the great occipital nerve, as already seen. Occasionally there is a second cutaneous nerve to the back of the head.

Great auricular

The *great auricular nerve* (fig. 205) is derived from the second and third cervical nerves. Perforating the deep fascia at the posterior border of the sterno-mastoid muscle, the nerve is directed upwards between the platysma towards the lobule of the ear, and ends in the following branches:—

supplies facial,

The *facial branches* are sent forwards to the integuments over the parotid, and a few slender filaments pass into the gland to join the facial nerve.

auricular,

The *auricular branches* ascend to the external ear, and are chiefly distributed on its cranial aspect, but one or more reach the lower part of the outer surface. On the pinna they communicate with branches furnished from the facial and pneumo-gastric nerves.

and mastoid branches.

The *mastoid branch* is directed backwards to the skin over the mastoid process, where it joins the posterior auricular branch of the facial nerve.

Superficial cervical nerve.

The *superficial cervical nerve* (fig. 205, [14]) arises from the cervical plexus in common with the preceding, and turns forward round the sterno-mastoid muscle about the middle. Afterwards it pierces the fascia, and ramifies over the anterior triangle. There may be more than one branch to represent this nerve.

Nerves that descend are

The descending set of branches (fig. 210) are derived from the third and fourth nerves of the plexus, and are directed towards the clavicle over the lower part of the triangular space. Their number is somewhat uncertain, but usually there are about three near the clavicle.

usually three branches.

The most internal branch (*sternal*) crosses the clavicle near its inner end; the middle branch (*clavicular*) lies about the middle of

that bone; and the external (*acromial*) turns over the clavicular attachment of the trapezius to the acromion. All are distributed to the skin of the chest and shoulder.

Derived from the descending set are one or two *posterior cutaneous nerves of the neck*, which ramify in the integument covering the trapezius above the scapula. Posterior cervical cutaneous.

The *lymphatic glands* lying along the sterno-mastoid (glandulæ concatenatæ) are some of the *deep cervical glands*, and are continuous through the lower part of the posterior triangular space with the glands of the axilla. A chain of *superficial cervical glands* accompanies the external jugular vein; and close to the skull, over the apex of the posterior triangular space, are one or two small *sub-occipital glands*; while farther forwards, resting on the insertion of the sterno-mastoid, there are two or three small *mastoid glands*. Lymphatic glands of neck.

FRONT OF THE NECK.

Directions. Having displayed the chief structures in the posterior triangle, the student will expose those in the anterior.

Dissection. The skin over the front of the neck is to be turned forwards to the middle line. Beneath the skin is the superficial fat, containing very fine offsets of the superficial cervical nerve. To raise skin,

To define the platysma muscle, remove the fat which covers it, carrying the knife downwards and backwards in the direction of the fleshy fibres. to show platysma.

PLATYSMA MYOIDES. The anterior part of the platysma, viz., from the sterno-mastoid muscle to the lower jaw, covers the greater portion of the anterior triangular space. At the base of the jaw it is *inserted* between the symphysis and the masseter muscle; while other and more posterior fibres are continued over the face, joining the depressor anguli oris and risorius, as far as the fascia covering the parotid gland, or even to the cheek-bone. Anterior part of platysma: insertion into jaw.

The fibres have the same appearance in this as in the posterior half of the muscle, but they are rather stronger. Below the chin the inner fibres of opposite muscles frequently cross for a short distance, but those of them which are superficial do not always belong to the same side in different bodies. Crossing of the fibres.

Action. The hinder part of this muscle draws the corner of the mouth downwards and outwards; the fore part is used in swallowing, and carries forwards the skin of the upper part of the neck, thus facilitating the upward movement of the larynx. When the muscle contracts forcibly, the skin of the upper part of the chest and shoulder is also raised. Use on mouth in swallowing.

Dissection. Raise the platysma to the base of the jaw, and dissect out beneath it the branches of the superficial cervical nerve, and the cervical branch of the facial nerve. Clean also the deep fascia of the neck, and the anterior jugular vein which is placed near the middle line. Dissection.

The SUPERFICIAL CERVICAL NERVE has just been traced from its origin in the cervical plexus to its position on the deep fascia of the Superficial cervical nerve;

neck. Beneath the platysma it divides into an upper and a lower branch :—

ascending. The *upper branch* perforates the platsyma, and ends in the skin over the anterior triangle, extending about half way down the neck. While beneath the platysma this branch joins the facial nerve.

descending branch. The *lower branch* likewise passes through the platysma, and is distributed to the integuments below the preceding, reaching as low as the sternum.

Branch of facial nerve to the neck. The INFRAMAXILLARY BRANCH OF THE FACIAL NERVE (p. 564) pierces the deep cervical fascia, and divides into slender offsets which pass forwards beneath the platysma, and form arches across the side of the neck (fig. 205), reaching as low as the hyoid bone. Most of the branches end in the platysma, but a few filaments perforate it, and reach the integuments. Beneath the muscle there is a communication between this branch of the facial and the upper division of the superficial cervical nerve.

Dissection. **Dissection.** Cut across the external jugular vein about the middle, and throw the ends up and down. Afterwards the superficial nerves of the front of the neck may be divided in a line with the angle of the jaw, the anterior ends being removed, and the posterior reflected. The great auricular nerve may be cut through and the ends reflected.

Cervical fascia in front of sterno-mastoid. The part of the DEEP CERVICAL FASCIA in front of the sterno-mastoid is stronger than that over the posterior triangle, and has the following arrangements. Above, it is fixed to the base of the lower jaw, and is continued over the parotid gland to the zygoma. A thickened band passes backwards from the angle of the jaw to the sheath of the sterno-mastoid, and holds forwards the anterior border of that muscle. Above this, a deep process is sent inwards from the hinder margin of the ramus of the jaw, between the parotid and submaxillary glands, to the styloid process, giving rise to the *stylo-maxillary ligament.* In front, the fascia is attached to the body of the hyoid bone ; and below, to the sternum. Its lower part forms a dense white membrane, which near the manubrium becomes divided into two layers, one passing in front and the other behind that bone, so as to enclose a small space above it containing a little fat and the transverse branch of communication between the anterior jugular veins.

Intermuscular strata. Layers of the membrane are prolonged between the muscles ; and that beneath the sterno-mastoid is continuous with the sheath of the cervical vessels. One of these, beneath the sterno-thyroid muscles, descends in front of the great vessels at the root of the neck to the arch of the aorta and the pericardium.

ANTERIOR TRIANGULAR SPACE.

Anterior triangular space. This space (fig. 211, p. 582) contains the carotid vessels and their branches, with many nerves ; and it corresponds with the hollow on the surface of the neck in front of the sterno-mastoid muscle.

Dissection. To define the anterior triangular space and its contents, take away the deep fascia of the neck and the subjacent fat, but without injuring or displacing the several parts. First clean the surface of the muscles below the hyoid bone, leaving untouched the anterior jugular vein. Dissection of anterior triangle.

The trunks into which the large carotid artery bifurcates are to be followed upwards, especially the more superficial one (external carotid), the branches of which are to be traced as far as they lie in the space. In removing the sheath from the vessels, as they appear from beneath the muscles at the lower part of the neck, the dissector should be careful of the small descending branch of the hypoglossal nerve on the surface of the artery. In the sheath between the vessels (carotid artery and internal jugular vein) will be found the pneumogastric nerve, and behind the sheath lies the sympathetic nerve. Trace arteries. Seek longitudinal nerves,

Clean the digastric and stylo-hyoid muscles, which cross the space in the direction of a line from the mastoid process to the hyoid bone (fig. 209, p. 573), and beneath them look for several nerves. Thus, crossing the carotid arteries just below the digastric is the hypoglossal nerve, which gives off its descending branch in front of the artery, and further forwards a smaller offset to the thyro-hyoid muscle. Under cover of the muscles, and taking a similar direction between the two carotid arteries, are the glosso-pharyngeal nerve and the stylo-pharyngeus muscle. Directed downwards and backwards from beneath the same muscles to the sterno-mastoid is the spinal accessory nerve. and transverse nerves. Spinal accessory.

On the inner side of the vessels, between the hyoid bone and the thyroid cartilage, the dissector will find the superior laryngeal nerve; and by the side of the larynx, with the descending part of the superior thyroid artery, the small external laryngeal branch. Laryngeal nerves.

Clean then the submaxillary gland close to the base of the jaw; and on partly displacing it from the surface of the mylo-hyoid muscle, the student will expose the small branch of nerve to that muscle with the submental branch of the facial artery. Clean gland, seek nerve to mylo-hyoid.

The interval between the jaw and the mastoid process has been already cleaned by the removal of the parotid gland in the dissection of the facial nerve.

Limits of the space (fig. 211). Behind, is the sterno-mastoid muscle; and in front, the boundary is formed by a line from the chin to the sternum, along the middle of the neck. Above, at the base of the space, are the lower jaw, the skull, and the ear; and below, at the apex, is the sternum. Over this space are placed the skin, the superficial fascia with the platysma, the deep fascia, and the ramifications of the facial and superficial cervical nerves, together with the anterior jugular vein. Boundaries.

Muscles in the space. In the area of the triangular interval, as it is above defined, are seen the larynx and pharynx in part, and many muscles converging towards the hyoid bone, some being above and some below it. Below are the depressors of that bone, viz., omo-hyoid, sterno-hyoid, and sterno-thyro-hyoid (^{2} to ^{4}); and above Contents of the space.

are the elevator muscles, viz., mylo-hyoid, digastric, and stylo-hyoid. Connected with the back of the hyoid bone and the larynx are two of the constrictor muscles of the pharynx.

Carotid artery in space: course;

Vessels in the space. The *carotid blood vessels* and the *internal jugular vein* (6 and 7) occupy the hinder and deeper part of the space along the side of the sterno-mastoid muscle; and *their course* would be

FIG. 211.—ANTERIOR TRIANGULAR SPACE OF THE NECK (QUAIN'S "ARTERIES").

1. Sterno-mastoid.
2. Sterno-hyoid.
3. Anterior belly of omo-hyoid.
4. Thyro-hyoid.
6. Common carotid artery dividing.
7. Internal jugular vein.
8. External jugular vein.

In the original drawing the sterno-mastoid is partly cut through.

marked on the surface by a line from the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process. As high as the level of the cricoid cartilage they are buried beneath the depressor muscles of the hyoid bone; but beyond that spot they are covered by the superficial layers over the space, and by the sterno-mastoid muscle which, before it is displaced, conceals the vessels as far as the parotid gland.

coverings;

bifurcation.

For a short distance after its exit from beneath the depressor muscles of the hyoid bone, the common carotid artery remains a single trunk; but *opposite*, or a little above, *the upper border of the thyroid cartilage* it divides into two large vessels, external and internal carotid. From the place of division these arteries are continued onwards beneath the digastric and stylo-hyoid muscles to the interval between the jaw and the mastoid process.

Position of two trunks to one another.

At first the trunks lie side by side, the vessel destined for the internal parts of the head (internal carotid) being the posterior of the two; but above the digastric muscle it becomes deeper than the other.

Branches.

The more superficial artery (external carotid) furnishes many branches to the neck and the outer part of the head, viz., some forwards to the larynx, tongue, and face; others backwards to the occiput and the ear; and others upwards to the head.

Changes in the place of division of carotid.

But the common carotid does not always divide as here said. For the point of branching of the vessel may be moved from opposite the upper border of the thyroid cartilage, either upwards or downwards, so that the trunk may remain undivided till it is beyond the hyoid bone, or it may end opposite the cricoid cartilage. The division beyond the usual place is more frequent than the branching short of that spot. It may ascend as an undivided trunk (though very rarely) furnishing offsets to the neck and head.

Jugular vein;

In close contact with the outer side of both the common and the internal carotid artery, and encased in a sheath of fascia with them, is the large internal jugular vein, which receives branches in the neck corresponding to some of the branches of the superficial artery.

position varies.

In some bodies the vein covers the artery; and the branches joining it above may form a kind of plexus over the upper end of the common carotid.

Nerves with the arteries

Nerves in the space. In connection with the large vessels are the following nerves with a longitudinal direction:—On the surface of the common carotid artery, and most frequently within the sheath, lies the descending branch of the hypoglossal nerve (descendens cervicis);

lying along

posteriorly between the artery and jugular vein is the pneumogastric nerve; and behind the sheath is the sympathetic nerve. Along the outer side of the vessels the spinal accessory nerve extends for a short distance, until it pierces the sterno-mastoid muscle.

and crossing them.

Several nerves are placed across the vessels:—thus, directed transversely over the two carotids, so as to form an arch below the digastric muscle, is the hypoglossal nerve giving off its descending branch. Appearing on the inner side of the carotid arteries, close to the base of the space, is the glosso-pharyngeal nerve, which courses forwards between them. To the inner side of the internal carotid artery, opposite the hyoid bone, the superior laryngeal nerve comes into sight; while a little lower down, with the descending branches of the thyroid artery, is the external laryngeal branch of that nerve.

Glands: submaxillary,

Glands in the space. Two large glandular bodies, the submaxillary (fig. 213, [11], p. 589) and thyroid ([12]), have their seats in this

triangular space of the neck. The submaxillary gland is placed altogether in front of the vessels, and is partly concealed by the jaw; beneath it, on the surface of the mylo-hyoid, is the small nerve to that muscle, with the submental artery. By the side of the thyroid cartilage, between it and the common carotid artery, lies the thyroid body beneath the sterno-thyroid muscle; in the female this body is more largely developed than in the male.

and thyroid body.

Parotid gland.

At the upper part of the neck, if the parts were not disturbed, would be the parotid gland, wedged into the hollow between the jaw and the mastoid process, and projecting somewhat below the level of the jaw.

Lymphatic glands.

Several lymphatic glands, belonging to the deep cervical group, lie along the internal jugular vein, under cover of the sterno-mastoid muscle; and another set of smaller glands (*submaxillary lymphatic glands*) is placed below the base of the jaw.

Directions. The student has now to proceed with the examination of the individual parts that have been referred to in the triangular spaces.

Anterior jugular vein

ANTERIOR JUGULAR VEIN. This vein lies near the middle line of the neck, and its size is dependent upon the degree of development of the external jugular. Beginning in some small branches below the chin, the vein descends to the sternum, and then bends outwards beneath the sterno-mastoid muscle, to open into the external jugular, or into the subclavian vein. In the neck the anterior and external jugular veins communicate. There are two anterior jugular veins, one for each side, though one is usually larger than the other; and at the bottom of the neck they are joined by a transverse branch (fig. 171, p. 467).

joins external jugular.

In many subjects the lower part of the anterior jugular vein is joined by a considerable branch which runs downwards, along the anterior border of the sterno-mastoid muscle, from the facial vein.

Sterno-mastoid muscle

The STERNO-CLEIDO-MASTOID MUSCLE (fig. 211, [1]) forms the superficial prominence of the side of the neck. It is narrower in the centre than at the ends, and *arises* below by two heads of origin which are separated by an elongated interval. The inner, or *sternal*, head is fixed by a narrow tendon to the anterior surface of the first piece of the sternum; and the outer, or *clavicular*, has a wide fleshy attachment to the inner third of the clavicle. From this origin the heads are directed upwards, the sternal passing backwards, and the clavicular almost vertically, and join about the middle of the neck in a flattened belly. Near the skull the muscle ends in a broad tendon, which is *inserted* into the mastoid process at its outer aspect from tip to base, and by a thin aponeurosis into a rough surface behind that process, and into the outer part of the upper curved line of the occipital bone.

has its origin at sternum and clavicle,

and insertion at skull:

position to other parts;

The muscle divides the lateral surface of the neck into the two main triangular spaces. On its cutaneous aspect it is covered by the integuments, the platysma, and the deep fascia, and is crossed by the external jugular vein, and by the great

auricular and superficial cervical nerves. If the muscle be cut through below and raised, it will be seen to lie on the following parts:—The clavicular origin is superficial to the anterior scalenus and omo-hyoid muscles, the transverse cervical and suprascapular arteries, and the phrenic nerve. The sternal head conceals the depressors of the hyoid bone, and the common carotid artery with its vein and nerves. After the union of the heads, the muscle is placed over the cervical plexus, the middle scalenus, and the elevator of the angle of the scapula; and near the skull on the digastric and splenius muscles, the occipital artery, and part of the parotid gland. The spinal accessory nerve perforates the muscular fibres about the junction of the upper and middle thirds.

Action. Both muscles acting bend the cervical part of the spine, carrying the head forwards; but one muscle will turn the face to the opposite side. In conjunction with other muscles attached to the mastoid process, one sterno-mastoid will incline the head towards the shoulder of the same side. use.

In laborious respiration the two muscles will assist in elevating the sternum.

The OMO-HYOID MUSCLE crosses beneath the sterno-mastoid, and consists of two fleshy bellies united by a small intermediate tendon. The *origin* of the muscle from the scapula, and the relations of the posterior belly have been studied in the dissection of the back (p. 522). From the intervening tendon the anterior fleshy belly (fig. 211, [3]) is directed upwards along the outer border of the sterno-hyoid muscle, and is *inserted* into the lower border of the body of the hyoid bone, close to the great cornu. Omo-hyoid muscle begins at the scapula, and ends at hyoid bone:

The anterior belly is in contact with the fascia, after escaping from beneath the sterno-mastoid, and rests on the sterno-thyroid and thyro-hyoid muscles. This part of the muscle crosses the carotid vessels on a level with the cricoid cartilage. relations;

Action. The omo-hyoid muscle depresses and tends to draw backwards the hyoid bone. use.

The STERNO-HYOID MUSCLE (fig. 211, [2]) is a flat thin band nearer the middle line than the preceding. It *arises* from the inner end of the clavicle at its posterior aspect, from the back of the manubrium and of the cartilage of the first rib. From this origin it ascends to be *inserted* into the lower border of the body of the hyoid bone, internal to the preceding muscle. Its fibres are often interrupted near the clavicle by a tendinous intersection. Sterno-hyoid muscle:

One surface is covered by the sterno-mastoid and the fascia. When the muscle is divided and turned aside, the deep surface will be found to rest on the sterno-thyroid, the thyro-hyoid, and the thyroid cartilage. The right and left muscles are separated by an interval which is wider below than above. relations;

Action. It draws the hyoid bone downwards after swallowing; and in laborious respiration it will aid in raising the sternum. use.

The STERNO-THYROID MUSCLE is broader and shorter than the sterno-hyoid, beneath which it lies. It *arises* from the posterior surfaces of the sternum and the cartilage of the first rib below the Sterno-thyroid muscle:

sterno-hyoid, and is *inserted* into the oblique line on the side of the thyroid cartilage, where it meets the thyro-hyoid muscle.

relations; The inner border touches its fellow below, while the outer reaches over the carotid artery. The superficial surface is for the most part covered by the preceding hyoid muscles; and the deep surface is in contact with the lower part of the common carotid artery, the trachea, the larynx, and the thyroid body. A transverse tendinous line frequently crosses the muscle near the sternum.

use. *Action.* Its chief use is to draw downwards the larynx after deglutition, but in conjunction with the following muscle it can also act on the hyoid bone.

Like the sterno-hyoid it participates in the movement of the chest in laborious breathing.

Thyro-hyoid muscle: The THYRO-HYOID MUSCLE (fig. 211, 4) forms a continuation of the sterno-thyroid. *Arising* from the oblique line of the thyroid cartilage, the fibres ascend to the anterior half of the great cornu, and the outer part of the body of the hyoid bone.

On the muscle lie the omo-hyoid and the sterno-hyoid; and beneath it are the superior laryngeal nerve and vessels.

use. *Action.* It draws up the larynx towards the hyoid bone, as in swallowing. The sterno-thyroid and thyro-hyoid together fix the thyroid cartilage for the action of the intrinsic muscles of the larynx.

Dissection. The sterno-hyoid and sterno-thyroid muscles should now be raised and the thyroid gland cleaned as it overlies the larynx and trachea. The muscles should not be divided but should be rendered slack for the purpose required by bending the neck forward. Care should be taken not to injure the vessels of the gland, and the inferior thyroid vein should be cleaned as it runs down the front of the trachea.

Thyroid body The THYROID BODY (fig. 212 and fig. 213, 12, p. 589) is a soft reddish mass, which embraces the upper part of the trachea. It

consists of two lobes and a cross piece. consists of two lateral lobes, united by a narrow piece across the front of the windpipe. The connecting piece, from a quarter to three-quarters of an inch in depth, is named the *isthmus*, and is placed over the second, third, and fourth rings of the trachea.

Relations and Each lobe is somewhat conical in shape, with the smaller end upwards, and is about two inches in length. It is interposed between the windpipe with the larynx and the sheath of the common carotid artery, and is covered by the sterno-thyroid, sterno-hyoid,

extent of lobes. and omo-hyoid muscles. The extent of the lobe varies; but usually it reaches as high as the middle of the thyroid cartilage, and as low as the sixth ring of the trachea.

Middle lobe or pyramid. From the upper border of the thyroid body, a conical process, known as the *pyramid*, often ascends towards the hyoid bone, to which it is attached by a fibrous band. The pyramid generally springs from the inner part of one of the lateral lobes, seldom from the isthmus; and it is sometimes connected to the hyoid bone by a

Accessory glands. slip of muscle, the *levator glandulæ thyroideæ*. Detached portions of

glandular substance, or *accessory thyroid glands*, are not unfrequently found between the main body and the hyoid bone.

The thyroid body is of a brownish red or purple hue, is granular in texture, and weighs from one to two ounces. It is larger in the woman than in the man. On cutting into the gland a viscid yellowish fluid escapes. It has not any excretory tube or duct. Weight and size. No duct.

The *arteries* of the thyroid body are two on each side—superior and inferior thyroid—and they will be subsequently examined. The branches of the external carotids (superior thyroid) ramify chiefly Arteries: superior,

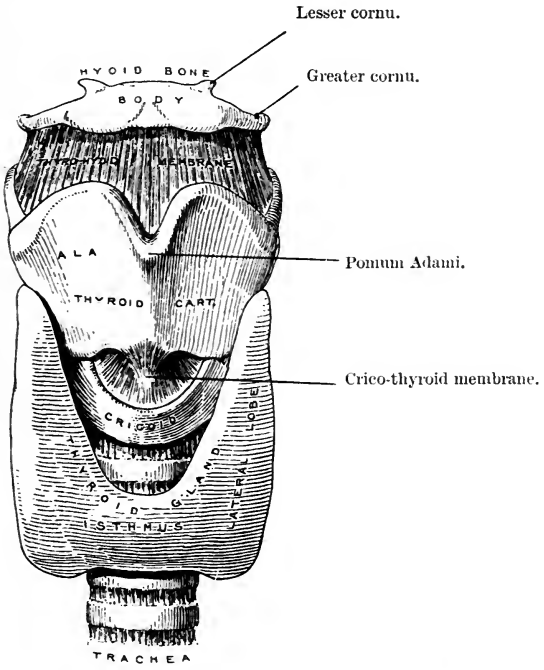


Fig. 212.—Diagram of the Thyroid Gland and Neighbouring Parts.

on the anterior aspect: while those from the subclavians (inferior thyroid) pierce the deep surface of the mass. inferior,

Occasionally there is a third branch (*art. thyroidea ima*) which arises from the innominate artery in the thorax, and ascending in front of the trachea assists in supplying the thyroid body. and sometimes lowest thyroid.

The *veins* are large and numerous; they are superior, middle, and inferior on each side. The first two enter the internal jugular vein. The *inferior thyroid veins* issue from the lower part of the thyroid body, and descend on the trachea, forming a plexus on that tube beneath the sterno-thyroid muscles, and finally enter the innominate veins by one or two trunks (fig. 171, p. 467). Veins. Inferior, form a plexus on trachea.

Directions. The remaining parts included in this section are the scaleni muscles and the subclavian blood-vessels, with the cervical nerves and the carotid blood-vessels. The student may examine them in the order here given.

Dissection

Dissection (fig. 213). The sterno-mastoid is to be cut and the fat and fascia taken away from the lower part of the neck so as to prepare the scaleni muscles with the subclavian vessels and their branches. By means of a little dissection the anterior scalenus muscle will be seen ascending from the first rib to the lower cervical vertebræ, having the phrenic nerve and subclavian vein in front of it, the latter crossing it near the rib.

of the subclavian artery

The part of the subclavian artery on the inner side of the scalenus is then to be cleaned, care being taken not only of its branches, but also of the branches of the sympathetic nerve which course over and along it from the neck to the chest. This dissection will be facilitated by the removal of the inner part of the clavicle.

and its branches;

All the branches of the artery are in general easily found, except the superior intercostal, which is to be sought in the thorax in front of the neck of the first rib. On, or near, the branch (inferior thyroid) ascending behind the carotid sheath to the thyroid gland, is the middle cervical ganglion of the sympathetic; and the dissector should follow downwards from it a small cardiac nerve to the thorax. Only the origin and first part of the arterial branches can be now seen; their termination is met with in other stages of the dissection.

of thoracic duct.

On the *left side* the student should seek the thoracic duct as it arches over the part of the subclavian artery internal to the scalenus muscle. If it is uninjected it looks like a vein, rather flattened, and smaller than a crow-quill; and it will be found about half an inch above the clavicle, crossing behind the internal jugular vein, and then bending downwards to end in the angle between the latter and the subclavian vein.

Right lymphatic duct;

The small right lymphatic duct at its entry into the veins in a corresponding position on the right side should also be found.

of brachial plexus;

The outer part of the subclavian artery having been already prepared, let the dissector remove more completely the fibrous tissue from the nerves of the brachial plexus. From the plexus trace down the small branch to the subclavius muscle in front of the subclavian vessels, and the branches to the rhomboid and serratus muscles, which pierce the middle scalenus. If it is thought necessary, the anterior scalenus may be cut through after the artery has been studied.

of cervical plexus.

Clean the cervical plexus, beginning with the nerves at their emergence in the neck in front of the origins of the scalenus medius and tracing them from this. Seek the muscular branches, the small twigs to join the descendens cervicis from the hypoglossal, and the roots of the phrenic nerve. Lastly, let the middle scalenus muscle be defined, as it lies beneath the cervical nerves.

The SCALENI MUSCLES are usually described as three in number, and are named from their relative position, anterior, middle, and posterior; they extend from the transverse processes of the cervical vertebræ to the first and second ribs. Number of scalene muscles.

The SCALENUS ANTICUS (fig. 213, [1]) is somewhat conical in shape, Scalenus anticus:

FIG. 213.—A VIEW OF THE COMMON CAROTID AND SUBCLAVIAN ARTERIES (QUAIN'S "ARTERIES").

1. Anterior scalenus, with the phrenic nerve on it.
2. Middle scalenus.
3. Levator anguli scapulæ.
4. Omo-hyoid.
5. Rectus capitis anticus major.
6. Common carotid artery.
7. Subclavian vein.
8. Subclavian artery.
9. Digastric muscle.
10. Parotid gland.
11. Submaxillary gland.
12. Thyroid body.
13. Trapezius muscle, reflected.

and *arises* from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ. It is *inserted* into the upper surface and inner border of the first rib, surrounding the rough mark or projection on this part of the bone known as the scalene tubercle(fig. 214, p. 590). origin; insertion;

relations, with vessels, and nerves: More deeply seated below than above, the muscle is concealed by the clavicle and the clavicular part of the sterno-mastoid: the phrenic nerve lies along its anterior surface, and the subclavian vein crosses over it near the rib. Along the inner border is the internal jugular vein. Beneath it are the pleura, the subclavian artery, and the nerves of the brachial plexus. The attachment to the vertebræ corresponds with the origin of the rectus capitis anticus major muscle.

use. *Action.* The muscle raises strongly the first rib, in consequence of its forward attachment. If the rib is fixed, it bends forwards the lower part of the neck.

Scalenus medius; origin: The SCALENUS MEDIUS MUSCLE (fig. 213, [2]) is larger than the anterior, and extends highest of all on the vertebræ. Its *origin* is

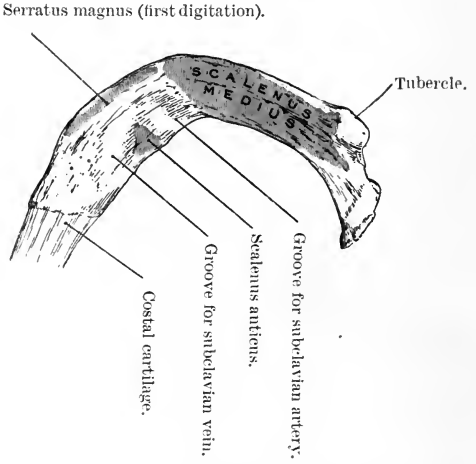


FIG. 214.—THE FIRST RIB, SHOWING THE UPPER SURFACE.

from the posterior tubercles of the transverse processes of all the cervical vertebræ except sometimes the first or the last; and it is insertion; *inserted* into an impression on the upper surface of the first rib, extending from the tuberosity behind to the groove for the subclavian artery in front (fig. 214).

parts in contact with it; In contact with the anterior surface are the subclavian artery and the cervical nerves, together with the sterno-mastoid muscle: the posterior surface rests on the posterior scalenus, and the deep, lateral muscles of the back of the neck. The fibres are perforated by the nerves of the rhomboid and serratus magnus muscles.

use. *Action.* Usually it elevates the first rib. With the rib fixed, the cervical part of the spine can be inclined laterally by one muscle.

Scalenus posticus: The SCALENUS POSTICUS is inconsiderable in size, and appears to be part of the preceding muscle. *Arising* from two or three of

the lower cervical transverse processes, it is *inserted* below, by a thin tendon about half an inch wide, into the second rib in front of the serratus posticus superior. attachments;

Action. It acts as an elevator of the second rib; and its fibres having the same direction as those of the medius, it will help to incline the neck in the same way. use.

The SUBCLAVIAN ARTERY (fig. 213) is the first portion of the large trunk which supplies the upper limb with blood, and is thus designated from its position beneath the clavicle. *On the right side*, this vessel is derived from the bifurcation of the innominate artery behind the sterno-clavicular articulation, and the part of it named subclavian extends as far as the outer border of the first rib. *On the left side* the artery arises in the thorax from the arch of the aorta, and the first part therefore has a longer course, and the special points in connection with the vessel will be mentioned after a general description of the vessel in the neck has been given. To reach the limb the artery crosses the lower part of the neck, taking an arched course over the top of the lung and the first rib, and between the scaleni muscles. For the purpose of describing its numerous connections the vessel is *divided into three parts;* the first extending from the sterno-clavicular articulation to the inner border of the anterior scalenus; the second, beneath the scalenus; and the third, from the outer border of that muscle to outer edge of the first rib. Subclavian artery extends to upper limb, is divided into three parts.

FIRST PART. Internal to the anterior scalenus the artery lies deeply in the neck, and ascends somewhat from its origin. Between the vessel and the surface will be found the common tegumentary coverings with the platysma and the deep fascia; the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles; and a strong deep process of fascia from the inner border of the scalenus muscle. Behind and below, it rests upon the pleura, which ascends into the arch formed by the vessel; and the apex of the lung separates the artery from the vertebræ and the posterior ends of the first and second ribs. First part, internal to scalenus, is deep. In front of, behind, and below it

Veins. The innominate vein lies below and rather in front of this part of the artery. The internal jugular vein crosses the arterial trunk close to the scalenus; and underneath this vein, with the same direction, lies the vertebral vein. Much more superficial, and separated from the artery by muscles, is the deep part of the anterior jugular vein. Veins with the artery.

Nerves. In front of the artery lies the pneumo-gastric nerve, near to the internal jugular vein; and inside this, the lower cardiac branch of the same nerve trunk. Beneath the subclavian artery on the right side winds the recurrent branch of the pneumo-gastric; and one or two branches of the sympathetic nerve form loops round the vessel. Position of nerves.

SECOND PART. Beneath the scalenus the vessel is not so deep as in the first part of its course, and at this spot it rises highest above the clavicle. It is covered by the integuments, platysma, and deep fascia: then by the clavicular origin of the sterno-mastoid; and Second part beneath scalenus. In front,

behind and below. lastly by the anterior scalenus. Behind and below the artery are the pleura and lung.

Position of vein; *Veins.* Below the level of the artery, and separated from it by the anterior scalenus muscle, lies the arch of the subclavian vein.

of nerves to the artery. *Nerves.* In front of the scalenus descends the phrenic nerve. Above the vessel, in the interval between the scaleni, are placed the large cervical nerves; and the trunk formed by the last cervical and first dorsal nerves is behind the artery.

Third part THIRD PART. Beyond the scalenus the artery traverses the clavicular part of the posterior triangular space (fig. 210), and is

is superficial. nearer the surface than in the rest of its course: this part of the vessel is enclosed in a sheath of the deep cervical fascia, which it receives as it passes from between the scaleni. It is comparatively

Parts covering it; superficial in the greater part of its extent, for it is covered only by the integuments, the platysma, and deep fascia; but near its termination the vessel gets under cover of the clavicle and subclavius muscle, and the suprascapular vessels cross in front of it.

and beneath. In this part of its course the artery rests on the surface of the first rib, which is interposed between it and the pleura; and the insertion of the scalenus medius is behind it.

Position of veins; *Veins.* The subclavian vein approaches the artery, not being separated by muscle, but lies commonly at a lower level. The external jugular vein crosses it near the scalenus muscle; and the suprascapular and transverse cervical tributaries, which enter the jugular, sometimes form a plexus over this part of the artery.

of nerves to artery. *Nerves.* The large nerves of the brachial plexus are mostly above the artery, but the lowest trunk is still behind and close to it, and the small nerve to the subclavius crosses it about the middle. Superficial to the cervical fascia lie the descending cutaneous branches of the cervical plexus.

Peculiarities of origin, *Peculiarities.* The artery may spring as a separate trunk from the arch of the aorta, in which case it takes a deeper course than usual to reach the interval between the scaleni muscles.

level and course. The level of the arch formed by the subclavian artery in the neck varies in different subjects, and occasionally the vessel pierces, or even passes in front of the scalenus anticus muscle.

Branches of subclavian: ORIGIN OF BRANCHES. The chief branches of the subclavian artery are four in number. Three of these arise from the first part

from first, of the arterial trunk:—one (*vertebral*) ascends to the head; another (*internal mammary*) descends to the chest; and the remaining one (*thyroid axis*) is a short thick trunk, which furnishes branches inwards and outwards to the thyroid body and the shoulder. These arise commonly near the inner border of the scalenus anticus muscle, so as to leave an interval at the beginning of the trunk free from offsets. This interval varies in length from half an inch to an inch in the greater number of cases; and its extremes range from less than a quarter of an inch to an inch and three quarters. In some instances the branches are scattered over the first part of the artery.

second, On the right side the fourth branch (*superior intercostal*) arises beneath the anterior scalenus from the second part of the artery,

and gives off the deep cervical branch: a small spinal artery frequently comes from this part of the trunk. On the left side the origin of this vessel is usually from the first part of the artery, a little internal to the scalenus anticus.

If there is a branch present on the third part of the artery, it is commonly the posterior scapular: if more than one, the internal mammary, the suprascapular, or the thyroid axis may be added. and third part.

The LEFT SUBCLAVIAN ARTERY arises from the arch of the aorta, instead of from an innominate trunk, and ascends thence over the first rib in its course to the upper limb. With this difference on the two sides in the origin of the subclavian—the one vessel beginning opposite the sterno-clavicular articulation, the other in the thorax—it is evident that the length and relations of the part of the artery on the inner side of the scalenus anticus must also differ on the two sides. Left subclavian artery differs much from right subclavian

First part. The part of the artery internal to the anterior scalenus is much longer on the left than on the right side. It ascends nearly vertically from its origin to the level of the first rib, and then bends somewhat abruptly outwards over the top of the lung. On leaving the chest it is deeply placed in the neck, near the spine and the œsophagus, and does not rise usually so high above the first rib as the right subclavian. in the first part:

Between the artery and the surface are structures like those on the right side, viz., the integuments with the platysma and deep fascia, and the sterno-mastoid, hyoid, and thyroid muscles. To the inner side are the œsophagus and the thoracic duct, the latter arching forwards above this part of the artery; and the pleura is in contact with the outer and posterior surfaces. Its relations lower in the chest are described in the dissection of the thorax (p. 468). relations to surrounding parts;

Veins. The internal jugular and vertebral veins, as well as the beginning of the innominate, are in front of this part of the artery. veins;

Nerves. The pneumo-gastric nerve lies parallel to the vessel instead of across it as on the right side; and the phrenic nerve crosses over it close to the scalenus. Accompanying the artery are the cardiac branches of the sympathetic, which course along its inner side to the chest. position of nerves.

The *second* and *third parts* of the artery and its branches are essentially the same as on the right side. Rest of artery.

BRANCHES OF THE SUBCLAVIAN. 1. The *vertebral artery* is generally the first and largest branch of the subclavian, and arises from the upper and posterior part of the trunk. Ascending between the contiguous borders of the scalenus anticus and longus colli muscles, this branch enters the foramen in the transverse process of the sixth cervical vertebra, and is continued upwards to the skull through the foramina in the other cervical vertebræ. Before the artery enters its aperture it lies behind the internal jugular vein, and is crossed by the inferior thyroid artery (fig. 213). It is accompanied by branches of the sympathetic nerve, and supplies small muscular offsets. Its farther course and distribution will be given afterwards. Vertebral artery in the neck. Small branches.

Vertebral vein, and branches.

The *vertebral vein* issues with its accompanying artery, to which it is here superficial, and descends over the subclavian artery to join the innominate vein; it receives the *deep cervical vein*, and the branch (*anterior vertebral vein*) that accompanies the ascending cervical artery.

Internal mammary artery in the neck.

2. The *internal mammary artery* leaves the lower part of the subclavian artery, and coursing downwards beneath the clavicle, and on the outer side of the innominate vein, enters the thorax between the cartilage of the first rib and the pleura. As the artery disappears in the chest, it is crossed superficially by the phrenic nerve. The vessel is distributed to the walls of the chest and abdomen; and its anatomy has been learnt with the dissection of those parts (see p. 440).

Thyroid axis

3. *Thyroid axis.* This is a short thick trunk (fig. 213) which arises from the front of the subclavian artery near the anterior

divides into three.

scalenus muscle, and soon divides into three branches—one to the thyroid body, and two to the back of the shoulder.

Supra-scapular artery.

a. The *suprascapular branch* courses outwards across the lower part of the neck, behind the clavicle and subclavius muscle, to the superior border of the scapula, and entering the supraspinous fossa is distributed on the dorsum of that bone. The connections of this artery have been more fully seen in the dissection of the back.

Transverse cervical artery:

b. The *transverse cervical branch*, usually larger than the preceding, takes a similar direction, though higher in the neck, and ends beneath the border of the trapezius muscle in superficial cervical and posterior scapular branches as already traced. In its course outwards through the posterior triangular space, this branch crosses in front of the anterior scalenus, the phrenic nerve, and the brachial plexus, but usually behind the omo-hyoid. Some small

offsets,

offsets are supplied by it to the parts in the posterior triangle.

size and ending vary.

In many bodies the transverse cervical vessel is of small size, and ends as the superficial cervical artery, while the posterior scapular branch arises separately from the third, or even from the second part of the subclavian trunk (fig. 213).

Inferior thyroid artery

c. The *inferior thyroid artery* is the largest offset of the thyroid axis. Directed inwards with a flexuous course to the thyroid body, this branch passes beneath the common carotid artery and the accompanying vein and nerves, and in front of the longus colli muscle, to the side of the trachea. Behind the lateral lobe of the thyroid body it crosses either in front of or behind the recurrent nerve, and divides into branches which enter the lower part of the gland, and communicate with the superior thyroid and its fellow.

gives laryngeal offset,

Near the larynx an *inferior laryngeal branch* is directed upwards with the nerve of the same name, and other offsets are furnished to the trachea and œsophagus, and to the neighbouring muscles.

and ascending cervical branch.

The *ascending cervical branch* is directed upwards between the origins of the scalenus anticus and rectus capitis anticus major, and ends in branches to those muscles and the posterior triangle of the neck. Some small spinal offsets enter the spinal canal through the intervertebral foramina.

The *veins* corresponding with the branches of the thyroid axis have the following destination :—those with the suprascapular and transverse cervical arteries open into the external jugular vein. But the inferior thyroid vein, beginning in the thyroid body, descends on the front of the trachea to the innominate vein. Veins corresponding to arteries.

4. The *superior intercostal artery* arises from the posterior part of the subclavian under cover of the scalenus anticus on *the right side* and internal to the muscle on *the left*. It arches over the apex of the lung, and passes downwards in front of the neck of the first rib ; its distribution to the first two intercostal spaces has been seen in the thorax (p. 483). Superior intercostal branch.

Arising in common with this branch is the *deep cervical artery*, which passes backwards between the transverse process of the last cervical vertebra and the first rib, lying internal to the two hinder scaleni muscles and the fleshy slips continued upwards from the erector spinæ, to end beneath the complexus muscle at the posterior part of the neck as already seen (p. 532). Deep cervical branch.

A *spinal branch* is frequently given from the second part of the subclavian artery ; its offsets are continued into the spinal canal through the intervertebral foramina. Spinal branch.

The SUBCLAVIAN VEIN is much shorter than the companion artery, reaching only from the outer edge of the first rib to the inner border of the anterior scalenus. It is a continuation of the axillary vein, and ends by joining the internal jugular in the innominate trunk. Its course is arched below the level of the artery, from which it is separated by the scalenus anticus. Subclavian vein.

Branches. The subclavian vein is joined at the outer edge of the anterior scalenus by the external jugular vein, and sometimes also by the anterior jugular. Into the angle of union of the subclavian and internal jugular veins the right lymphatic duct opens (fig. 215,[9]) ; and at the like spot on the left side, the large lymphatic or thoracic duct ends (fig. 215, [8]). The highest pair of valves in the subclavian trunk is placed outside the opening of the external jugular vein. Its branches : opening of lymphatic ducts. Valves.

It should be borne in mind that occasionally the vein is as high in the neck as the third part of its companion artery ; and that it has been seen in a few instances with the artery beneath the anterior scalenus. Position may vary.

The THORACIC DUCT conveys the chyle and lymph of the greater part of the body into the venous circulation. Escaping from the thorax on the left side of the œsophagus, the duct ascends in the neck as high as the seventh cervical vertebra. At the spot mentioned it issues from beneath the carotid artery and the internal jugular vein, and arches outwards and downwards above or over the subclavian artery, and in front of the anterior scalenus muscle and phrenic nerve, to open into the angle of junction of the subclavian with the internal jugular vein. Double valves, like those of the veins, are present in the interior of the tube ; and a pair guards the opening into the posterior part of the vein. Frequently the upper part of the duct is divided ; and there may be separate openings into the large veins corresponding with those divisions. Thoracic duct comes from the thorax, and joins veins ; valves ; frequent variety ;

branches. Large lymphatic vessels from the left side of the head and neck, and from the left upper limb, open into the upper part of the duct, and sometimes separately into the veins (10).

Cervical nerves: The ANTERIOR PRIMARY BRANCHES OF THE CERVICAL NERVES spring from the common trunks in the intervertebral foramina, and appear on the side of the neck between the intertransverse muscles.

position and number. These nerves are eight in number, and are equally divided between the cervical and brachial plexuses; the upper four being combined in the former, and the remaining nerves in the latter plexus. Close to their origin they are joined by offsets of communication from the sympathetic cord.

First two differ from rest. To this general statement some addition is needed for the first two nerves, the peculiarities of which will be noticed later.

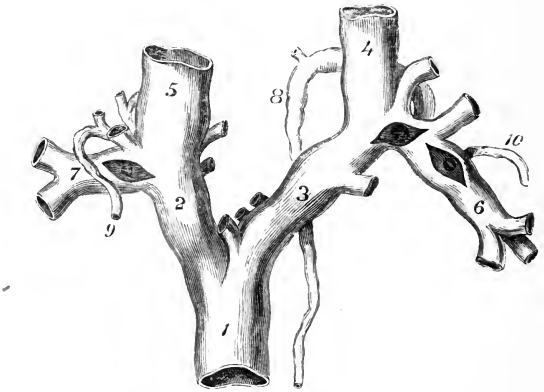


FIG. 215.—DIAGRAM OF THE ENDING OF THE RIGHT LYMPHATIC DUCT AND THE THORACIC DUCT IN THE VEINS.

1. Upper vena cava.
2. Right, and 3, left innominate vein.
4. Left, and 5, right internal jugular.
6. Left, and 7, right subclavian vein.
8. Thoracic duct.
9. A lymphatic trunk joining the right lymphatic duct, as this is about to end in the subclavian vein.
10. A lymphatic trunk opening separately into the left subclavian vein.

Brachial plexus, formed by five nerves. BRACHIAL PLEXUS (fig. 216). The lower four cervical nerves and the larger part of the first dorsal are blended in this plexus; and a fasciculus is added to them from the lowest nerve entering the cervical plexus. Thus formed, the plexus reaches from the neck to the axilla, where it ends in nerves for the upper limb. Only the part of it above the clavicle can now be seen. In the neck the nerves lie at first between the scaleni muscles, opposite the four lower cervical vertebræ, and afterwards in the posterior triangular space. The arrangement of the nerves in the plexus is as follows:—

Disposition of nerves in the plexus. The fifth and sixth nerves unite near the vertebræ, forming an *upper primary trunk*; the seventh remains distinct and constitutes

a *middle trunk*; and the eighth cervical and first dorsal join beneath the anterior scalenus in a *lower trunk*. Near the outer border of

Three primary trunks.

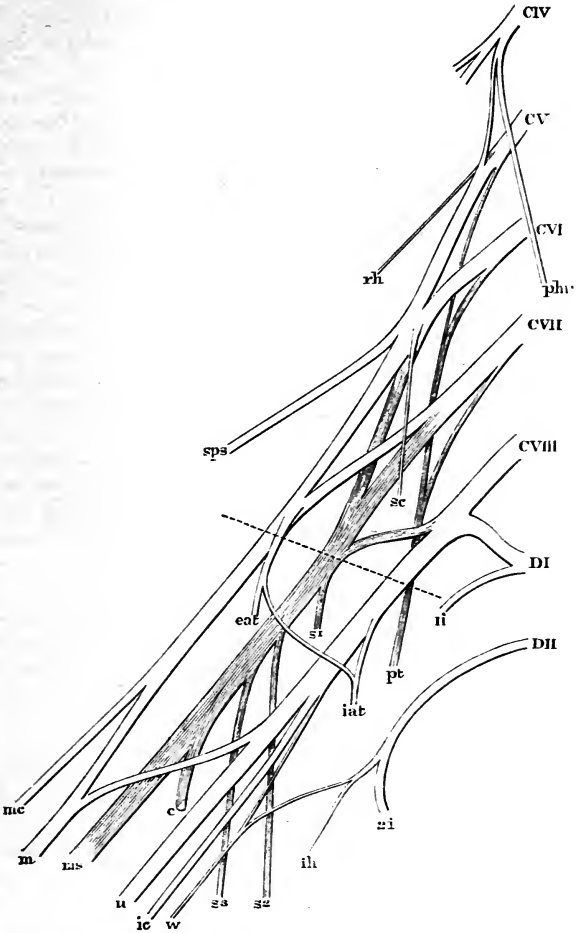


FIG. 216.—DIAGRAM OF THE BRACHIAL PLEXUS. THE DOTTED LINE INDICATES THE LEVEL AT WHICH THE CORDS ARE CROSSED BY THE CLAVICLE.

CIV. to CVIII. Fourth to eighth cervical nerves.
DI, and DII. First and second dorsal nerves.
1i, and 2i. First and second intercostal nerves.
phr. Phrenic nerve.
rh. Nerve to rhomboids.
pt. Posterior thoracic nerve.
sc. Branch to subclavius.
sps. Suprascapular nerve.

the middle scalenus these three trunks bifurcate, each giving off an *anterior* and a *posterior division*. As they pass beneath the clavicle the anterior divisions of the upper and middle trunks join

Each divides into anterior and posterior branches.

Cords of the brachial plexus.

to form the *outer cord* of the plexus; the posterior divisions of the three trunks by their union give rise to the *posterior cord;* while the large anterior division of the lower trunk is continued as the *inner cord.* The three cords accompany the subclavian artery, lying to its acromial side, and are continued to the axilla where the nerves of the limb arise.

Branches in the neck are :—

Branches. The branches of the plexus may be classed into those above the clavicle, and those below that bone. Those of the upper set end mostly in muscles of the lower part of the neck and of the scapula; while the lower set consists of the branches to the upper limb, with which they have been described.

Nerves of scaleni and longus colli.

BRANCHES ABOVE THE CLAVICLE. *Branches for the scaleni and longus colli muscles.* These small twigs arise from the nerves close to the intervertebral foramina, and are seen when the anterior scalenus is divided.

Nerve of rhomboids.

The *branch for the rhomboid muscles* (fig. 216, rh) springs from the fifth nerve, and perforates the fibres of the scalenus medius; it is directed backwards beneath the levator anguli scapulæ to its destination. Branches are given usually from this nerve to the levator anguli scapulæ.

Nerve of serratus.

The *nerve of the serratus* (pt), the posterior, or long, thoracic nerve, arises from the fifth, sixth, and generally also the seventh, nerves near the intervertebral foramina. Piercing the fibres of the scalenus medius lower than the preceding branch, the nerve is continued downwards behind the brachial plexus, and enters the serratus magnus muscle on its axillary surface.

Nerve of subclavius.

The *nerve of the subclavius muscle* (sc) is a slender branch, which arises from the trunk formed by the fifth and sixth nerves, and is directed downwards over the subclavian artery to the deep surface of the muscle; it often sends a twig to the phrenic nerve at the lower part of the neck.

Suprascapular nerve.

The *suprascapular nerve* (sps) is the largest of these branches, and arises from the trunk of the plexus formed by the fifth and sixth nerves. It is destined for the muscles on the dorsum of the scapula, and has been dissected with the arm.

Offset to the phrenic.

Occasionally an offset from the fifth cervical trunk joins the phrenic nerve on the anterior scalenus muscle.

Cervical plexus.

The CERVICAL PLEXUS, formed by the upper four cervical nerves, lies beneath the upper half of the sterno-mastoid muscle, and on the middle scalenus and the levator anguli scapulæ. Each nerve entering the plexus, except the first, divides into an ascending and a descending branch, and these unite with corresponding parts of the adjacent nerves, so as to give rise to a series of arches. From these arches or loops the different branches arise :—

Arrangement of the nerves.

Its offsets are superficial;

The *branches* are *superficial* and *deep.* Those of the superficial set are again subdivided into *ascending* and *descending,* and have been described with the posterior triangular space of the neck (p. 578). The ascending branches may be now seen to spring from the union of the second and third nerves; and the descending, to take origin from the loop between the third and fourth nerves.

The *deep set* of branches remains to be examined: they are muscular and communicating, and may be arranged in an internal and an external series. and deep, which are:—

DEEP SET OF BRANCHES OF THE CERVICAL PLEXUS. 1. INTERNAL SERIES. The *phrenic* or muscular nerve of the diaphragm is derived from the fourth, or third and fourth nerves of the plexus; and it may be joined by a fasciculus from the fifth cervical nerve. Descending obliquely on the surface of the anterior scalenus (fig. 213) from the outer to the inner edge, it enters the chest in front of the internal mammary artery, but behind the subclavian vein, and traverses that cavity to reach the diaphragm. At the lower part of the neck the phrenic nerve is joined by a filament of the sympathetic, and sometimes by an offset of the nerve to the subclavius muscle. Phrenic nerve.

On the left side the nerve crosses over the first part of the subclavian artery.

The *branches to the ansa cervicis* are two in number: one arises from the second, and the other from the third cervical nerve. They are spoken of as the *communicantes cervicis nerves* and are directed inwards over or under the internal jugular vein to join in a loop with the descendens cervicis branch (p. 602) of the hypoglossal nerve in front of the common carotid artery. The loop of the communication of the nerves over the carotid artery is called the *ansa cervicis.* Nerves to ansa cervicis.

Muscular branches are furnished to the rectus anticus major and longus colli muscles from the trunks of the nerves close to the intervertebral foramina. Branches to prevertebral muscles.

Some *muscular* and *connecting branches* from the loop between the first two nerves will be afterwards seen. Branches of first nerve.

2. EXTERNAL SERIES. *Muscular branches* are supplied from the second nerve to the sterno-mastoid; from the third and fourth nerves to the levator anguli scapulæ and middle scalenus; and from the loop between the same nerves to the trapezius. Branches to muscles.

Connecting branches with the spinal accessory nerve exist in three places. First, in the sterno-mastoid muscle; next, in the posterior triangular space; and lastly, beneath the trapezius. The union with the branches distributed to the trapezius has the appearance of a plexus. Branches joining spinal accessory.

The COMMON CAROTID ARTERY is the chief vessel for the supply of blood to the neck and head (fig. 213, 6). The origin of the vessel differs on the two sides, being at the lower part of the neck on the right side, and in the thorax on the left side. Common carotid artery:

The cause and relations of the left artery in the neck are the same as those on the right side, and the description serves for both. (The part of the left common carotid artery in the thorax has been described on page 468.)

The right vessel commences opposite the sterno-clavicular articulation at the bifurcation of the innominate artery on the right side, and prolonged up from the thorax on the left, and ends at, or a little above, the upper border of the thyroid cartilage, on a level with the fourth cervical vertebra, by dividing into external and origin

course; internal branches. The course of the artery is along the side of the trachea and larynx, gradually diverging from the vessel on the opposite side in consequence of the increasing size of the larynx; situation. and its direction is marked by a line from the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process.

Contained in a sheath of cervical fascia with the internal jugular vein and the pneumo-gastric nerve, the common carotid artery has Parts covering it, the following connections with the surrounding parts :—As high as the cricoid cartilage the vessel is deeply placed, and is concealed by the common coverings of the skin, platysma, and fasciæ; and by the muscles at the lower part of the neck, viz., sterno-mastoid (sternal origin), sterno-hyoid, omo-hyoid, and sterno-thyroid. But from the cricoid cartilage to its termination the artery is more superficial, being covered only by the sterno-mastoid and the common investments of beneath it, the neck. The vessel rests mostly on the longus colli and scalenus anticus muscles, but close to its ending on the rectus capitis anticus and on its sides. major. To the inner side of the carotid lie the trachea and larynx, the œsophagus and pharynx, and the thyroid body, the last overlapping the vessel by the side of the larynx. Along the outer side of the carotid sheath is a chain of lymphatic glands.

Position of veins, *Veins.* The large internal jugular vein lies on the outer side of the artery, being closely applied to it in the upper part of its course, but separated from it below by an interval about half an inch wide: on the left side the vein is nearer to the artery below and is even sometimes placed over it. One or two superior thyroid veins cross the upper end of the arterial trunk; and opposite the thyroid body another small vein (middle thyroid) is directed backwards over the vessel. Near the clavicle the anterior jugular vein passes outwards in front of the artery, but is separated from it by the sterno-hyoid and sterno-thyroid muscles.

of arteries, *Arteries.* An offset of the superior thyroid artery to the sterno-mastoid descends over the upper part of the sheath; and the inferior thyroid crosses behind it near the lower border of the cricoid cartilage.

of nerves to carotid. *Nerves.* The descendens cervicis branch of the hypoglossal lies in front of the artery, crossing from the outer to the inner side, and is joined there by the communicating branches from the cervical plexus. The pneumo-gastric lies within the sheath behind and between the artery and the vein. The sympathetic cord and its branches rest on the spine behind the sheath. All the nerves above mentioned have a longitudinal direction; but the inferior or recurrent laryngeal crosses obliquely inwards beneath the sheath, towards the lower end of the artery.

Branches none. As a rule, the common carotid artery does not furnish any collateral branch, though it is very common for the superior thyroid to spring from its upper end. At the terminal bifurcation into the two carotids the artery is slightly bulged.

Internal jugular vein The INTERNAL JUGULAR VEIN extends upwards to the base of the skull, but only the part of it that accompanies the common carotid

artery is now seen. Placed on the outer side of the artery, the vein ends below by uniting with the subclavian to form the innominate trunk. Its proximity to the carotid is not equally close throughout, for at the lower part of the neck there is a space between the two, in which the vagus nerve is seen crossing (on the right side only) the subclavian artery. Sometimes the vein overlaps the artery to a considerable extent.

is close to side of artery, except below:

The lower part of the vein is marked by a dilatation or sinus. Near its ending it becomes contracted, and is provided with a single or double valve.

In this part of its course the vein receives the superior and middle thyroid branches.

branches.

Peculiarities of the carotid. The origin of the artery on the right side may be above or below the point stated. Mention has been made of the difference in the place of bifurcation, and of the fact that the common carotid may not be divided into two. As a very rare occurrence, instead of one there may be two trunks issuing from beneath the hyoid muscles.

Differences in origin of artery, in division.

Dissection. The dissector may next trace out completely the trunk of the *external carotid* (fig. 217, p. 603), and follow its branches until they disappear beneath different parts. Afterwards he may separate from one another the digastric and stylo-hyoid muscles, which cross the carotid, and define their origin and insertion.

Dissection.

The DIGASTRIC MUSCLE (fig. 213, [9], p. 589) consists of two fleshy bellies, united by an intervening tendon. The posterior, the larger of the two, *arises* from the digastric fossa on the inner side of the mastoid process; while the anterior belly is fixed to the depression by the side of the symphysis of the lower jaw. From these attachments the fibres are directed to the intervening tendon, which is surrounded by fibres of the stylo-hyoid, and is united by an aponeurotic expansion to its fellow and to the body and part of the great cornu of the hyoid bone.

Digastric muscle has two bellies, which are joined by a tendon:

The arch formed by the digastric is superficial, except at the posterior end, where it is beneath the sterno-mastoid and splenius muscles. The posterior belly covers the carotid vessels and the accompanying veins and nerves; and is placed across the anterior triangular space of the neck in the position of a line from the mastoid process to the fore part of the hyoid bone. Along its lower border lie the occipital artery and the hypoglossal nerve, the former passing backwards, the latter forwards. The anterior belly rests on the mylo-hyoid muscle.

position to other parts.

The muscle forms the lower boundary of a space between it, the jaw, and the base of the skull, which is subdivided into two by the stylo-maxillary ligament. In the posterior portion are contained the parotid gland ([10]), and the vessels and nerves in connection with it; in the anterior, are the submaxillary gland ([11]), with the facial and submental vessels, and deeper still, the muscles between the chin and the hyoid bone.

The muscle bounds a space containing glands.

Action. The lower jaw being moveable, the muscle depresses

Use.

that bone and opens the mouth. If the jaw be fixed, the two bellies acting together will elevate the hyoid bone.

Stylo-hyoid muscle:

The STYLO-HYOID MUSCLE (fig. 224, H, p. 624) is thin and slender, and lies immediately above the posterior belly of the digastric. It *arises* from the posterior surface of the styloid process near the base,

insertion;

and is *inserted* into the outer part of the body of the hyoid bone.

surrounds digastric tendon;

The muscle has the same relations as the posterior belly of the digastric; and its fleshy fibres are usually perforated by the tendon of that muscle.

use.

Action. This muscle elevates the hyoid bone in swallowing, and with the posterior belly of the digastric, prevents the bone being carried forwards by the elevators.

Twelfth nerve in the anterior triangle:

The HYPOGLOSSAL NERVE (twelfth cranial) (fig. 224, 6), appears in the anterior triangle at the lower edge of the digastric muscle, where it hooks round the occipital artery; it is then directed forwards to the tongue beneath the tendon of that muscle, and disappears in front under the mylo-hyoid. In this course the nerve passes over the two carotids; and near the great cornu of the

branches:

hyoid bone it also crosses the lingual artery. From this part arise the descending branch, and a small muscular offset to the thyro-hyoid.

one to hyoid muscles

The *descendens cervicis* branch leaves the trunk of the hypoglossal as it turns round the occipital artery, and descends on the front of, or more frequently within, the carotid sheath to below the middle

is joined with cervical nerves.

of the neck, where it is joined by the communicating branches of the cervical nerves so as to form a single or double loop (*ansa cervicis*) with the concavity turned upwards. The descending branch gives an offset to the anterior belly of the omo-hyoid; and from the loop branches proceed to the posterior belly of the omo-hyoid, to the sterno-hyoid and sterno-thyroid muscles: sometimes another offset is continued to the thorax, where it joins the phrenic and cardiac nerves.*

External carotid artery;

The EXTERNAL CAROTID ARTERY (fig. 217, *d*) springs from the bifurcation of the common carotid opposite the thyro-hyoid membrane, and furnishes branches to the neck, and face, and the outer part of the head.

extent;

From the place of origin it ascends in front of the mastoid process, and ends just below the neck of the lower jaw in the

course and direction.

internal maxillary and superficial temporal branches. The artery lies at first in front of the internal carotid, but it afterwards inclines somewhat backwards and becomes superficial to that vessel. Its position would be marked with sufficient accuracy by a line from the front of the meatus of the ear to the cricoid cartilage.

Parts superficial to it,

At first the external carotid is overlain by the sterno-mastoid, and by the common coverings of the anterior triangular space, viz., the skin, and the superficial and deep fasciæ with the platysma. But above the level of a line from the mastoid process to the hyoid

* Both the descending and the thyro-hyoid branches of the hypoglossal are composed of fibres which pass from the first and second cervical nerves into the trunk of the nerve near the base of the skull.

bone, the artery is crossed by the digastric and stylo-hyoid muscles ; and higher still it is concealed by the parotid gland. At its beginning the artery rests against the pharynx ; but above the angle of the jaw it is placed over the styloid process and the stylo- beneath it,

Fig. 217.—External Carotid and its Superficial Branches ("Anatomy of the Arteries," Quain).

a. Common carotid.
b. Internal jugular vein.
c. Internal carotid.
d. External carotid.
e. Superior thyroid.
f. Lingual.
g. Facial.
h. Internal maxillary.
i. Superficial temporal.
m. Supraorbital.
n. External nasal.
o. Angular branch of facial.
p. Lateral nasal.
r. Superior coronary.
s. Inferior coronary.
t. Inferior labial.
u. Submental artery.

pharyngeus muscle, which separate it from the internal carotid. In front of the upper part of the vessel are the ramus of the jaw and the stylo-maxillary ligament. and in front.

Veins. There is not any companion vein with the external carotid, as with most arteries ; but in the parotid gland the temporo- Veins in contact with the artery ;

maxillary vein lies on it, and the anterior division of this trunk frequently runs with the artery beneath the digastric muscle. Near the beginning it is crossed by the facial and lingual veins joining the internal jugular vein.

and nerves. *Nerves* are directed from behind forwards over and under the artery. At the lower border of the digastric the hypoglossal lies over the vessel, and above that muscle it is crossed by the two divisions of the facial nerve. Three nerves lie beneath it—beginning below, the small external laryngeal; a little higher, the superior laryngeal; and near the angle of the jaw, the glosso-pharyngeal.

Its branches are anterior, The BRANCHES of the external carotid are numerous, and are classed into *anterior*, *posterior*, and *ascending* sets. The anterior set comprises branches to the thyroid body, the tongue, and the

posterior, face, viz., the superior thyroid, lingual, and facial arteries. In the

and ascending: posterior set are the occipital and posterior auricular branches. And the ascending set includes the ascending pharyngeal, superficial temporal, and internal maxillary arteries. Besides these, the external carotid gives other branches to the neighbouring muscles and to the parotid gland.

changes in origin and in number. The arrangement of the branches of the carotid may be altered by their closer aggregation on the trunk. The usual number may be diminished by two or more uniting into one; or it may be increased by some of the secondary offsets being transferred to the parent trunk.

Branches now seen are— *Directions.* All the branches, except the ascending pharyngeal, lingual and internal maxillary, may now be examined; but those three will be described afterwards with the regions they occupy.

Superior thyroid The SUPERIOR THYROID ARTERY (*e*) arises near the great cornu of the hyoid bone, and passes beneath the omo-hyoid, sterno-hyoid and sterno-thyroid muscles to the thyroid body, to which it is distributed chiefly on the anterior aspect. This artery is superficial in the anterior triangle, and furnishes offsets to the lowest constrictor muscle of the pharynx and to the muscles beneath which it lies, in addition to the following named branches :—

has these offsets;

the hyoid branch, *a.* The *hyoid branch* is very small, and runs inwards below the hyoid bone: it supplies the muscles attached to that bone, and anastomoses with the vessel of the opposite side.

to sterno-mastoid muscle, *b.* A *sterno-mastoid branch* descends in front of the sheath of the common carotid artery, and is distributed chiefly to the muscle from which it takes its name.

to larynx, *c.* The *superior laryngeal artery* pierces the membrane between the hyoid bone and the thyroid cartilage, with the superior laryngeal nerve, and ends in the interior of the larynx.

to crico-thyroid membrane. *d.* A small *crico-thyroid branch* is placed on the membrane between the cricoid and thyroid cartilages, and communicates with the corresponding artery of the opposite side, forming an arch.

Accompanying vein. The *superior thyroid vein* commences in the larynx and the thyroid body, and crosses the end of the common carotid artery to open into the internal jugular vein.

The Facial Artery (*g*) arises above the lingual; and is directed upwards over the lower jaw to the face. In the neck the artery passes under the digastric and stylo-hyoid muscles, and then beneath the submaxillary gland, under cover of which it makes a sigmoid turn. Its anatomy in the face has been given already (pp. 557 *et seq.*). From the cervical part branches are given to the pharynx, and to structures below the jaw, viz. :— Facial artery supplies branches in neck

a. The *inferior* or *ascending palatine branch* ascends to the pharynx beneath the jaw, passing between the stylo-glossus and stylo-pharyngeus muscles, and is distributed to the soft palate, which it reaches by turning over the upper border of the superior constrictor muscle. Its place in the palate is frequently supplied by an offset of the ascending pharyngeal artery. to the palate,

b. The *tonsillar branch* is smaller than the preceding, and passes between the internal pterygoid and stylo-glossus muscles. Opposite the tonsil it perforates the superior constrictor muscle, and ends in offsets to that body. tonsil,

c. Glandular branches are supplied to the submaxillary gland from the part of the artery in contact with it. submaxillary gland,

d. The *submental branch* arises near the inferior maxilla, and courses forwards on the mylo-hyoid muscle to the anterior belly of the digastric, where it ends in offsets: some of these turn over the jaw to the chin and lower lip; and the rest supply the muscles between the jaw and the hyoid bone, one or two perforating the mylo-hyoid and anastomosing with the sublingual artery. mylo-hyoid muscle and chin.

The *facial vein* (p. 559) joins the internal jugular. In the cervical part of its course it receives branches corresponding to the offsets of the artery; and it frequently sends a considerable branch downwards to join the anterior jugular vein. Facial vein.

The Occipital Artery springs from the carotid opposite the facial branch, near the lower border of the digastric muscle, and ascends to the inner side of the mastoid process. Here it turns backwards in the occipital groove of the temporal bone, passing above the transverse process of the atlas, and then runs between the muscles attached to the occipital bone, to become cutaneous and ramify over the back of the head (p. 503). In the part of its course now exposed the artery lies beneath the digastric muscle, and crosses over the internal carotid artery, the internal jugular vein, and the spinal accessory and hypoglossal nerves. Occipital artery ends on occiput;

The occipital artery gives small branches to the surrounding muscles, and one larger branch to the sterno-mastoid, which bends downwards over the hypoglossal and enters the muscle in company with the spinal accessory nerve: this branch frequently arises directly from the external carotid. In some bodies there is also a small *meningeal branch* entering the skull by the jugular foramen. The offsets at the back of the neck are seen in the dissection of that region (p. 532). a sterno-mastoid branch; sometimes a posterior meningeal.

The *occipital veins* are two or three in number, and pass downwards between the muscles of the back of the neck to enter the deep Occipital veins.

cervical vein. They communicate through the mastoid foramen with the lateral sinus in the interior of the skull.

Posterior auricular: The POSTERIOR AURICULAR ARTERY is smaller than the preceding branch and takes origin above the digastric muscle. Between the ear and the mastoid process, it divides into two branches for the ear and occiput (p. 503).

a branch to tympanum. A small branch (*stylo-mastoid*), enters the foramen of the same name, and supplies the middle ear.

Posterior auricular vein. The *posterior auricular vein* is of considerable size, and descends over the upper end of the sterno-mastoid muscle to join the beginning of the external jugular.

Temporal artery: The SUPERFICIAL TEMPORAL ARTERY (*i*) is one of the terminal branches of the external carotid, and in direction forms the continuation of that trunk. Ascending in the parotid gland and over the posterior root of the zygoma, it divides on the temporal fascia

termination into anterior and posterior branches, which are distributed over the front and side of the head (p. 503). Before dividing the artery gives off the following branches:—

branches to parotid, to articulation, *a. Parotid branches* are furnished to the gland of the same name; *articular twigs* to the articulation of the lower jaw; and *muscular* branches to the masseter.

and to ear; *b.* Some *anterior auricular offsets* are distributed to the pinna and meatus of the external ear.

branch to face; *c.* The *transverse facial branch* leaves the temporal artery close to its origin, and is directed forwards over the masseter muscle (p. 559). On the side of the face it supplies the muscles and integuments, and anastomoses with the facial artery.

branch to temporal muscle *d.* The *middle temporal branch* pierces the temporal aponeurosis just above the zygoma, and enters the substance of the temporal muscle: it anastomoses with the deep temporal branches of the internal maxillary artery.

and fascia. *e.* A small *orbital branch* runs forwards between the layers of the temporal fascia, and is distributed to the superficial structures near the eye, anastomosing with an offset of the lachrymal artery.

Temporal vein. The *temporal vein* begins on the side of the head and lies with its artery in front of the ear. Near the zygoma it is joined by the middle temporal vein; it then receives branches corresponding to the other offsets of the artery; and it ends by uniting with the internal maxillary vein to form the temporo-maxillary trunk.

Dissection. **Dissection.** The trachea and œsophagus in the neck are now to be cleaned, but care should be taken not to injure the recurrent laryngeal nerves or the sympathetic nerves behind and to the inner side of the carotid sheath.

Trachea The TRACHEA, or windpipe, is continued from the larynx to the thorax, and ends by dividing into two tubes (bronchi), one for each

lies in neck and thorax: lung. It occupies the middle line of the body, and extends commonly from the lower part of the sixth cervical to the lower border

size; of the fourth dorsal vertebra, measuring about four inches and a half in length, and nearly one in breadth. The front and sides of the trachea are rounded in consequence of the existence of firm

cartilaginous bands in those parts of the wall; but at the posterior aspect the cartilages are absent, and the wall is flat and membranous. form.

The cervical part of the trachea is very moveable, and has the following relative position to the surrounding parts. Covering it in front are the depressor muscles of the hyoid bone, with the deep cervical fascia: beneath those muscles is the inferior thyroid plexus of veins; and near the larynx is the isthmus of the thyroid body. Behind the tube is the œsophagus, with the recurrent laryngeal nerves. On each side are the common carotid artery and the thyroid body. Cervical part is amongst muscles and vessels.

The ŒSOPHAGUS, or gullet, reaches from the pharynx to the stomach. It commences, like the trachea, opposite the lower part of the sixth cervical vertebra, and ends opposite the tenth dorsal vertebra. The tube reaches through part of the neck, and through the whole of the thorax. Its length is about nine inches. Œsophagus occupies neck and thorax: length.

In the neck its position is behind the trachea till near the thorax where it projects to the left side of the air tube, and touches the thyroid body and the thoracic duct. Behind the œsophagus are the longi colli muscles. On each side is the common carotid artery, the proximity of the left being greater, in consequence of the projection of the œsophagus towards that side. Position in neck, and relations.

The structure of the œsophagus will be examined in the dissection of the thorax.

Directions. The lower part of the neck will now be left for some days, so that the dissector should stitch together the flaps of skin if they remain, and carefully wrap up the part and apply preservative.

SECTION VII

THE PTERYGO-MAXILLARY REGION.

In this region are included the muscles superficial to and beneath the ramus of the lower jaw, together with the temporo-maxillary articulation. In contact with the muscles (pterygoid) beneath the jaw, are the internal maxillary blood-vessels, and the inferior maxillary trunk of the fifth nerve. Contents of the region.

Dissection. The masseter muscle, which is superficial to the bone, has been partly laid bare in the dissection of the face. To see it more fully, the branches of the facial nerve and the transverse facial artery should be cut through and turned backwards, and the fascia cleaned off the surface of the muscle. Dissection.

Should there be any tow or cotton-wool left in the mouth let it be removed.

The MASSETER (fig. 203, p. 553) *rises* by a flattened tendon from the lower border of the zygomatic arch, including a small portion of the malar process of the superior maxilla, and by fine fleshy fibres from the deep surfaces of the zygomatic process and the malar bone. It is *inserted* into the whole of the outer surface of the coronoid Masseter muscle: origin, and insertion;

process and ramus of the lower jaw, extending from the angle behind to the level of the second molar tooth in front. The superficial fibres are inclined downwards and backwards, and form a layer that can be readily separated from the deeper portion of the muscle, in which the fibres run nearly vertically.

consists of two layers;

The lower part of the masseter is covered only by the integuments, with the platysma and fascia; but the upper is partly concealed by the parotid gland, and is crossed by Stenson's duct, and by the transverse facial vessels and branches of the facial nerve. The anterior border projects over the buccinator muscle, and a quantity of loose fat resembling that in the orbit is found beneath it. The muscle covers the ramus of the jaw, and the masseteric nerve and artery entering its deep surface.

muscle nearly subcutaneous;

lies on the jaw;

Action. It raises the lower jaw with the internal pterygoid in the mastication of the food.

use.

Dissection. To lay bare the temporal muscle to its insertion, the following dissection is to be made:—The temporal fascia is to be detached from the upper border of the zygomatic arch and removed from the surface of the muscle. Next, the arch is to be sawn through in front and behind, so as to include all its length; and is to be thrown down (without being cut off) with the masseter still attached to it, by separating the fibres of that muscle from the ramus of the jaw. In detaching the masseter, its nerves and vessels, which pass through the sigmoid notch of the lower jaw, will come into view, and should be dissected out of the muscle.

To see surface of temporal muscle.

The surface of the temporal muscle may be then cleaned. And to expose its termination, let the coronoid process be sawn off by a cut passing from the centre of the sigmoid notch to the last molar tooth, so as to include the insertion of the muscle. Before sawing the bone let the student find and separate from the muscle the buccal vessels and nerve issuing from beneath it anteriorly. Lastly, the coronoid process should be raised and the fat removed, in order that the lower fibres of the temporal muscle and their contiguity to the external pterygoid beneath them may be seen.

To see the insertion.

The TEMPORAL MUSCLE (fig. 218, [1]) *arises* from the fascia covering it, and from the bones forming the inner wall of the temporal fossa (p. 506), reaching upwards to the semicircular line on the side of the skull, and downwards to the infratemporal crest on the great wing of the sphenoid bone. From this extensive origin the fibres converge to a tendon, which appears on the outer surface of the muscle, and is *inserted* into the borders and inner surface of the coronoid process, as well as into a groove on the front of the ramus of the lower jaw, extending downwards nearly to the last molar tooth.

Origin of temporal muscle;

insertion;

Behind the posterior border of the tendon are the masseteric vessels and nerve, and in front of it the buccal vessels and nerve: the last nerve occasionally perforates some of the fibres of the muscle.

relations;

Action. All the fibres contracting, the muscle will raise the mandible and press it forcibly against the upper jaw. The hinder fibres acting alone can retract the lower jaw after it has been moved forwards by the external pterygoid.

use.

Dissection. For the display of the pterygoid muscles (fig. 218), it will be necessary to remove a piece of the ramus of the jaw. But the greater part of the temporal muscle is to be first detached from the subjacent bone with the handle of the scalpel, and the deep temporal vessels and nerves are to be sought in its fibres. To dissect pterygoid muscles,

A piece of the ramus of the jaw is next to be taken away by sawing across the bone below the condyle, and close above the dental foramen; to protect the dental vessels and nerve in contact with its inner surface while doing this, the handle of the scalpel saw through ramus of the jaw;

FIG. 218.—SUPERFICIAL VIEW OF THE PTERYGOID REGION (QUAIN'S "ARTERIES").

1. Temporal muscle.
2. External pterygoid.
3. Internal pterygoid.
4. Buccinator.
5. Digastric and stylo-hyoid muscles, cut and thrown back.
6. Common carotid.
7. External carotid.
8. Internal maxillary artery passing beneath the external pterygoid.

may be inserted between them and the bone, and carried downwards to their entrance into the foramen.

After the loose piece of bone has been removed, and the subjacent parts freed from fat, the pterygoid muscles will appear,— the external (2) being directed backwards and outwards to the condyle, while the internal (3), which is somewhat parallel in direction to the masseter, descends to the angle of the jaw. In removing the abundant fatty tissue, the student must be careful not to take away the thin internal lateral ligament, which lies on the internal pterygoid muscle beneath the ramus. take it away and the fat.

Position of vessels. Running forwards over the external pterygoid muscle is the internal maxillary artery, which distributes offsets Position of vessels.

upwards and downwards: sometimes the artery is placed beneath the muscle as in fig. 218. The veins, which form a large plexus between the muscles, may be taken away.

Nerves. *Position of nerves.* Most of the branches of the inferior maxillary nerve are seen in this dissection, (fig. 219 and fig. 222, p. 616). Thus, the masseteric and posterior and middle deep temporal nerves appear between the upper border of the external pterygoid and the skull, while the buccal nerve, with the anterior deep temporal nerve, passes through the fore part of the muscle between its two heads. Issuing from beneath the lower border of the muscle are the large inferior dental and lingual nerves, the latter being the anterior of the two; and coming out behind the condyle of the jaw is the auriculo-temporal nerve. The small posterior dental branch of the superior maxillary nerve is also to be found, lying with the artery of the same name on the hinder part of the upper jaw.

External pterygoid: origin; The EXTERNAL PTERYGOID MUSCLE (fig. 218, 2) is triangular in shape, and *arises* by two heads, which are separated by an interval opposite the spheno-maxillary fossa. The upper head is the smaller, and is attached to the fore part of the zygomatic surface of the great wing of the sphenoid bone; the lower head springs from the outer surface of the external pterygoid plate. From this origin the

insertion, muscle runs backwards and outwards to be *inserted* into the hollow in front of the neck of the lower jaw-bone, and into the interarticular fibro-cartilage of the joint.

relations; Externally the pterygoid is concealed by the temporal muscle and the lower jaw; and the internal maxillary artery usually lies on it. Its deep surface is in contact with the internal pterygoid, the inferior maxillary nerve and its branches, and the internal lateral ligament of the jaw. Through the interval between the heads pass the buccal and anterior deep temporal nerves in a common stem and the internal maxillary artery, when the latter is placed beneath the muscle. The parts in contact with the borders of the external pterygoid have been enumerated above.

use of both muscles, *Action.* If both muscles contract, the jaw is moved directly forwards, so that the lower dental arch is placed in front of the

of one muscle. upper; but if one muscle act alone (say the right), the condyle of the same side is drawn forwards, and the grinding teeth of the lower jaw are moved obliquely to the left across those of the upper. By the alternate action of the two muscles the trituration of the food is mainly effected.

Internal pterygoid: origin; The INTERNAL PTERYGOID MUSCLE (fig. 218, 3) crosses the direction of the external, and is nearly parallel to the ramus of the jaw. It *arises* in the pterygoid fossa, mainly from the inner surface of the external pterygoid plate, and by a small slip from the outer surface of the tuberosity of the palate bone and the superior maxilla

insertion; in front of the pterygoid process. The fibres descend to be inserted into a rough mark on the inner side of the ramus of the lower jaw, extending from the inferior dental foramen to the angle.

contiguous parts; On the muscle are placed the inferior dental and lingual nerves, the inferior dental vessels, and the internal lateral ligament of the jaw.

Its deep surface is in relation with the superior pharyngeal constrictor below, and the tensor palati above. The origin of this muscle embraces the lower part of that of the external pterygoid.

Action. It acts with the masseter in raising the mandible. use.

TEMPORO-MAXILLARY ARTICULATION (figs. 220 and 221, p. 612). Joint of lower jaw.
This articulation is a compound joint, being formed by the condyle of the lower jaw and the fore part of the glenoid cavity of the temporal bone, with an interposed disc of fibro cartilage. The bones are united by the following ligaments :—

The *capsule* is a thin membranous tube which is attached above Capsule of the joint.
to the temporal bone around the articular surface, and below to the condyle of the lower jaw, reaching farther down behind than in front. The cavity in the interior is divided into two parts,

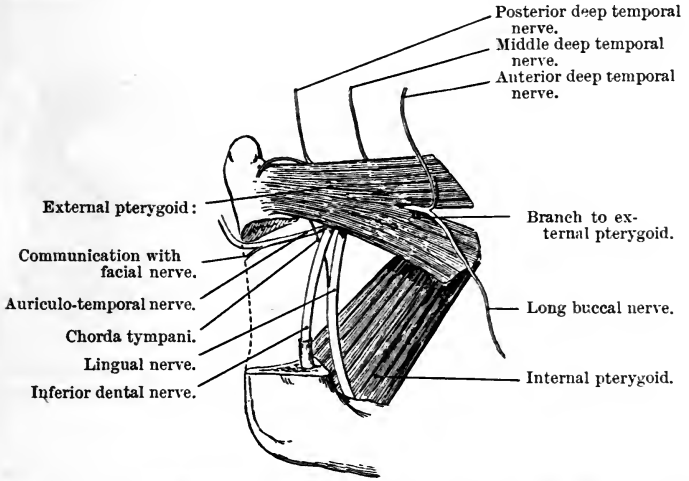


FIG. 219.—DIAGRAM SHOWING THE RELATIONS OF THE BRANCHES OF THE INFERIOR MAXILLARY NERVE TO THE PTERYGOID MUSCLES.

upper and lower, by the fibro-cartilage ; and the upper portion of the capsule is wider and looser than the lower.

The *external lateral ligament* is a thickened band of the capsule, External lateral,
composed of fibres passing from the tubercle at the root of the zygoma and the adjoining part of the outer surface of that process to the outer and posterior part of the neck of the lower jaw.

The *internal lateral ligament* (fig. 220, 1) is a long, thin, mem- and internal lateral ligament.
branous band, which is not in contact with this joint. Superiorly it is connected to a ridge on the inner side of the glenoid fossa, formed by the spinous process of the sphenoid and the vaginal process of the temporal bone ; and inferiorly it is inserted into the inner margin of the dental foramen in the lower jaw. The ligament lies between the jaw and the internal pterygoid : and its origin is concealed by the external pterygoid muscle. The internal

maxillary vessels, with the auriculo-temporal and inferior dental nerves, pass between the band and the ramus of the jaw.

Dissection.

Dissection. After the external lateral ligament and the capsule have been examined, the interarticular fibro-cartilage will be exposed by taking away the capsule on the outer side (fig. 221).

Fibro-cartilage; shape,

The *interarticular fibro-cartilage* (fig. 221, 4) is an oval plate, elongated transversely, and thinner in the centre, where it is sometimes perforated, than at the margins. The upper surface fits the articular hollow and eminence of the temporal bone, being convex behind and concave in front; and the lower is moulded to the convexity of the condyle of the jaw. By the circumference

and attachments;

it is connected with the capsule; and in front the external pterygoid muscle is attached to it.

use.

This interarticular disc allows a double movement to take place in the articulation, the condyle of the jaw revolving in the socket

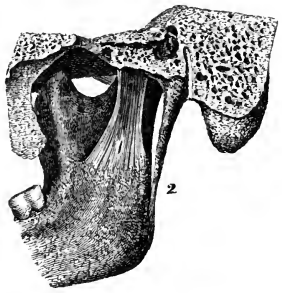


FIG. 220.—LIGAMENTS OF THE JAW—INNER VIEW (BOURGERY AND JACOB).

1. Internal lateral ligament.
2. Stylo maxillary.

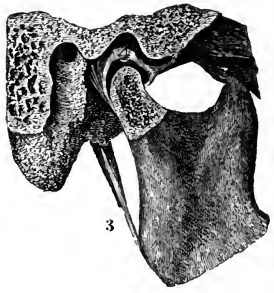


FIG. 221.—A VIEW OF THE INTERIOR OF THE TEMPORO-MAXILLARY JOINT (BOURGERY AND JACOB).

3. Stylo-maxillary ligament.
4. Interarticular fibro-cartilage: the dark intervals above and below the disc are the synovial cavities.

formed by the fibro-cartilage, while the latter glides forwards and backwards over the temporal articular surface.

Two synovial sacs.

Two *synovial sacs* are present in the articulation—a larger one above, and a smaller one below the fibro cartilage.

Stylo-maxillary ligament.

Another structure—the *stylo-maxillary ligament* (fig. 221, 3)—is described as a uniting band to the articulation. This is a process of the deep cervical fascia, which extends from the styloid process to the hinder border of the ramus of the jaw; it gives attachment to the stylo-glossus muscle, and separates the parotid and submaxillary glands.

Surfaces of jaw

Articular surfaces of the bones. The condyle of the jaw has a form resembling that of a part of a cylinder, with its axis directed obliquely from without inwards and somewhat backwards.

and temporal bone.

The upper articular surface is placed on the squamous part of

the temporal bone, and is larger than that on the jaw. It includes the deep oval hollow formed by the part of the glenoid fossa in front of the Glaserian fissure, and the convex surface, known as the articular eminence, which forms the anterior boundary of the hollow.

Movements of the joint. The lower jaw has up and down, forward and backward, and oblique movements. Kinds of movement.

In *depressing* the jaw, as in opening the mouth, the condyle moves forwards till it is placed under the convexity of the articular eminence; but the interposed concave fibro-cartilage gives security to the joint. Even with this provision, a slight degree more of sudden motion may throw the condyle off the prominence of the temporal bone into the zygomatic fossa, and give rise to dislocation. In opening the mouth how condyle moves. Dislocation.

In this movement the fore and lateral parts of the capsule are tightened; and the fibro-cartilage is drawn forwards with the condyle by the external pterygoid muscle. State of ligaments.

When the jaw is *elevated* and the mouth closed, the condyle and the fibro-cartilage glide back into the glenoid fossa; and the posterior part of the capsule is stretched. Shutting mouth.

During the *horizontal movements forwards* and *backwards* of the jaw the condyle is placed successively opposite the front and back of the temporal articular surface; and the fibro-cartilage always follows the condyle of the jaw, even in dislocation. Forward and backward movement.

Excessive motion forwards would be prevented by the coronoid process of the jaw striking against the zygomatic arch; and the backward movement is checked by the external lateral ligament and by the meeting of the condyle with the postglenoid process of the temporal bone.

The *oblique movement* is produced by the condyle of one side advancing on the articular eminence, while the other remains in the glenoid fossa. If the right condyle advances, the chin moves to the left side, and the grinding teeth of the lower jaw are carried obliquely to the left and forwards across the upper set. By the alternate action to opposite sides the food is triturated. Oblique movement, how produced.

Dissection. The condyle of the jaw is next to be disarticulated and drawn forwards with the attached external pterygoid muscle, so as to allow the inferior maxillary nerve to be seen (fig. 222, p. 616). While cutting through the joint-capsule, the dissector must be careful of the auriculo-temporal nerve close beneath. Dissection of inferior maxillary nerve,

On turning forwards the pterygoid muscle, and removing some fat and veins, the dissector will find the trunk of the inferior maxillary nerve. The masseteric, temporal, and buccal branches of the nerve should be traced to a common origin close below the foramen ovale of the sphenoid bone. The dental and lingual nerves should be cleaned beneath the muscle; and the auriculo-temporal nerve followed forwards with care from the back of the articulation to its origin from the trunk. The small chorda tympani is to be found joining the back of the lingual nerve near the skull. its trunk. and branches; of chorda tympani,

and arteries. The large meningeal artery and its offsets are to be sought beneath the external pterygoid. Sometimes the trunk of the internal maxillary artery lies beneath that muscle, and in that case, it and its branches are now to be cleaned.

Internal maxillary artery: The INTERNAL MAXILLARY ARTERY (fig. 218, [8]) is one of the terminal branches of the external carotid, and takes a winding course beneath the lower jaw and the temporal muscle to the spheno-maxillary fossa, where it ends in branches for the face, the interior of the nose, and the palate and pharynx.

course and relations; At first the artery is directed forwards between the ramus of the jaw and the internal lateral ligament of the joint, and crosses the inferior dental nerve; it then ascends over the lower portion of the external pterygoid, being placed between it and the temporal muscle; and finally, it turns inwards opposite the interval between the heads of the external pterygoid to gain the spheno-maxillary fossa. The

varies in its position. course of the artery is sometimes beneath, instead of over the external pterygoid; and when that is the case, the artery reaches the spheno-maxillary fossa by passing between the heads of the muscle.

Branches are in three sets. The BRANCHES of this artery are numerous, and are classed in three sets; the *first* set arises beneath the jaw: the *second* between the muscles; and the *third* in the spheno-maxillary fossa.

Those beneath jaw. Two chief branches, viz., the inferior dental and the great meningeal, leave the internal maxillary artery in its *first part* while it is in contact with the ramus of the jaw.

Inferior dental The INFERIOR DENTAL ARTERY descends between the internal lateral ligament and the jaw, and enters the foramen on the inner surface of the ramus, along with the companion nerve; it supplies the molar and bicuspid teeth, and ends in an *incisor* branch running forwards in the bone to the incisor and canine teeth, and in a small *mental* branch which issues from the bone through the foramen of that name to end on the face.

has a branch to mylo-hyoid muscle. As the artery is about to enter the foramen it furnishes a small *mylo-hyoid branch* to the muscle of that name; this is conducted by a groove on the inner surface of the bone, in company with a branch from the dental nerve, to the superficial surface of its muscle, where it anastomoses with the submental artery.

Great meningeal artery The GREAT MIDDLE MENINGEAL ARTERY is the largest branch of the internal maxillary, and arises opposite the preceding. It ascends beneath the external pterygoid muscle, and between the

ends in skull; roots of the auriculo-temporal nerve to the foramen spinosum of the sphenoid bone, through which it passes into the skull. Its course and distribution within the cranial cavity have been already

but gives seen (p. 514). Before the artery reaches the foramen, it usually furnishes the following small branches; but one or more of them may arise directly from the internal maxillary trunk:—

branch to tympanum, *a*. The TYMPANIC BRANCH passes into the tympanum through the Glaserian fissure, and is distributed to the tympanic membrane and parts within the tympanic cavity.

to meatus, *b*. A DEEP AURICULAR BRANCH usually arises with the former, enters the meatus through the cartilage or between that and

the bone, and ramifies in the meatus and on the tympanic membrane.

c. The SMALL MIDDLE MENINGEAL BRANCH begins near the skull, and courses through the foramen ovale with the inferior maxillary nerve: it ramifies in the dura mater in the middle fossa of the skull. — to dura mater.

Another small branch springs from the dental artery or from the internal maxillary trunk, and accompanying the lingual nerve, ends in the cheek and the mucous membrane of the mouth. — Branch with lingual nerve.

The *branches from the second part of the artery* (between the temporal and external pterygoid muscles) are distributed to the temporal, masseter, buccinator, and pterygoid muscles. — Branches of second part are—

The DEEP TEMPORAL ARTERIES are two in number, anterior and posterior, and ascend on the side of the skull beneath the temporal muscle. The posterior anastomoses with the middle temporal branch of the superficial temporal artery; the anterior communicates, through the malar bone, with branches of the lachrymal artery. — to the temporal muscle;

The MASSETERIC ARTERY is directed outwards with the nerve of the same name behind the tendon of the temporal muscle, and passing through the sigmoid notch, enters the deep surface of the masseter muscle. Its branches anastomose with the other offsets to the muscle from the external carotid trunk. — to the masseter;

The BUCCAL BRANCH quits the artery near the upper jaw, and descends beneath the insertion of the temporal muscle with its companion nerve: it is distributed to the buccinator muscle and other structures of the cheek, joining branches of the facial artery. — to the cheek;

The PTERYGOID BRANCHES are uncertain in their position and number; whether derived from the trunk or some of the branches of the internal maxillary, they enter the two pterygoid muscles. — to pterygoid muscles.

Of the branches that arise from the artery in *the third part* of its course, viz. in the spheno-maxillary fossa, only one, the *posterior dental*, will be now described. The remainder will be examined with the superior maxillary nerve and Meckel's ganglion; they are *infra-orbital*, *descending palatine*, *spheno-palatine*, *Vidian*, and *pterygo-palatine*. — Branches of third part: only one now seen

The POSTERIOR DENTAL BRANCH arises as the artery enters the spheno-maxillary fossa, and descends with a tortuous course on the zygomatic surface of the upper jaw, along with a small branch of the superior maxillary nerve. Its branches mostly enter the canals of the bone and supply the upper molar and bicuspid teeth, as well as the lining membrane of the antrum; some external offsets are furnished to the gum. — is the posterior dental.

The INTERNAL MAXILLARY VEIN is a short trunk, often double, which leaves the hinder part of the pterygoid plexus, and runs backwards, beneath the jaw with the first part of the internal maxillary artery, to join the superficial temporal vein in the parotid gland. — Internal maxillary vein arises from

The *pterygoid plexus* is an extensive network of veins surrounding the internal maxillary artery and the pterygoid muscles. Into it the veins corresponding to the branches of the artery empty themselves and it communicates with the cavernous sinus in the interior — pterygoid plexus: tributaries,

of the skull through the foramen ovale and foramen lacerum. From the plexus the large internal maxillary vein leads backwards, and outlets. and another considerable branch, the *anterior internal maxillary* or *deep facial vein*, descends to the face to join the facial vein. A prolongation of the plexus into the spheno-maxillary fossa is often distinguished as the *alveolar plexus*.

Inferior maxillary nerve. The INFERIOR MAXILLARY NERVE (fig. 222) is the largest of the three trunks arising from the Gasserian ganglion. It leaves the

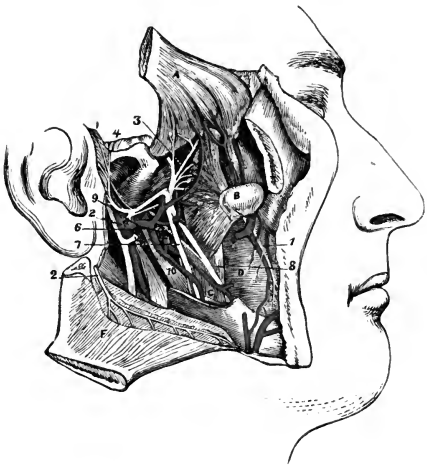


FIG. 222.—DEEP VIEW OF THE PTERYGOID REGION (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Temporal reflected.
B. Condyle of the jaw disarticulated forwards, with the external pterygoid attached to it.
C. Internal pterygoid.
D. Buccinator.
F. Masseter thrown down.

Nerves:

1. Buccal.
2. Masseteric, cut.
3. Deep temporal.
4. Auriculo-temporal.
6. Chorda tympani.
7. Inferior dental.
8. Lingual.
10. Internal lateral ligament of the lower jaw. The arteries are not numbered with the exception of the internal maxillary trunk, which is marked with 9.

skull by the foramen ovale in the sphenoid bone, and divides immediately below that opening into two principal pieces, viz., an *anterior* smaller part, which is distributed mainly to muscles, and a larger *posterior* part, ending in branches which are, with one exception, altogether sensory. In addition to these, the nerve of the internal pterygoid muscle arises from the inner side of the primary trunk.

Directions. Should the internal maxillary artery obstruct the view of the nerve, it may be cut through.

The ANTERIOR PART receives nearly all the fibres of the motor root of the nerve, and furnishes branches to three of the muscles of the jaw, viz., temporal, masseter, and external pterygoid, and the buccal branch to the cheek (fig. 219, p. 611). Anterior part

The *deep temporal branches* (fig. 219 and fig. 222, 3) are three in number, and enter the deep surface of the temporal muscle; the *middle*, which is the largest and supplies the greater part of the muscle, leaves the anterior division of the trunk and ascends close to the bone, above the upper border of the external pterygoid; the *posterior* is usually conjoined with the masseteric nerve, and enters the hinder part of the muscle; and the *anterior* is given off from the buccal nerve in front of the external pterygoid. supplies temporal branches, middle, posterior, and anterior.

The *masseteric branch* (2) takes an outward course above the external pterygoid muscle, and through the sigmoid notch, to the under surface of the masseter muscle, in which it can be followed to near the anterior border. As this branch passes by the articulation of the jaw it gives one or more twigs to that joint. Masseteric.

The *nerve to the external pterygoid* generally arises in common with the buccal nerve, and enters the deep surface of its muscle. Branch to external pterygoid.

The *buccal branch* (1), longer and larger than the others, is mainly a sensory nerve to the cheek. It is first directed forwards between the heads of the external pterygoid muscle, and then descends beneath the coronoid process and the insertion of the temporal muscle towards the angle of the mouth. After perforating the pterygoid, it gives off the anterior deep temporal nerve; and on the surface of the buccinator it divides into branches which form a plexus with the buccal branches of the facial nerve, and are finally distributed to the skin and mucous membrane of the cheek. Buccal nerve is sensory; gives off deep temporal.

The POSTERIOR PART of the inferior maxillary nerve divides into three branches—auriculo-temporal, inferior dental, and lingual (fig. 219). A few of the fibres of the motor root join the dental nerve, and are conveyed to the mylo-hyoid and digastric muscles. Posterior part of inferior maxillary.

The AURICULO-TEMPORAL NERVE (fig. 222, 4) arises from the trunk near the base of the skull, usually by two roots which embrace the middle meningeal artery. In its course to the surface of the head, it is first directed backwards beneath the external pterygoid muscle as far as the neck of the jaw, and then upwards with the superficial temporal artery in front of the ear. Its ramifications on the head are described at page 504. In the part now dissected its branches are the following:— Auriculo-temporal lies beneath jaw, and supplies branches

a. Branches to the meatus auditorius. Two offsets are given to the meatus from the nerve beneath the neck of the jaw, and enter that tube between the cartilage and bone. to the meatus,

b. Articular branch. The branch to the joint of the jaw arises near the same spot as the preceding, or from the branches to the meatus. joint of jaw,

c. The *inferior auricular branch* supplies the tragus and adjacent part of the pinna. the ear, and

d. Parotid branches. These small filaments ramify in the gland. parotid;

e. Communicating branches with the otic ganglion. One or two to join otic ganglion

filaments pass between the otic ganglion and the beginning of the auriculo-temporal nerve.

and facial nerve. *f. Branches to the facial nerve.* Two considerable branches pass forwards round the superficial temporal artery to join the upper trunk of the facial nerve.

Inferior dental The INFERIOR DENTAL (7) is the largest of the branches of the inferior maxillary nerve. In its course to the canal in the lower

is between pterygoid muscles, jaw, the nerve is placed behind and external to the lingual, and lies at first beneath the external pterygoid muscle; it afterwards rests on the internal pterygoid, and near the dental foramen on the internal lateral ligament. After the nerve enters the

then in the jaw, bone, it is continued forwards beneath the teeth to the foramen in the side of the jaw, and ends at that spot by dividing into an incisor and a mental branch. Only one offset (to the mylo-hyoid

and supplies muscle) leaves the dental nerve before it enters the bone. Its branches are:—

branch to mylo-hyoid, *a.* The *mylo-hyoid nerve* arises near the dental foramen, and is continued along a groove on the inner aspect of the ramus of the jaw to the cutaneous surface of the mylo-hyoid, and to the anterior belly of the digastric muscle.

b. The *dental branches* arise in the bone, and supply the molar

dental branches to grinding and bicuspid teeth. If the bone is soft, the canal containing the nerve may be laid open so as to expose these minute branches.

c. The *incisor branch* is small and continues the direction of the

and cutting teeth, nerve onwards to the middle line, furnishing offsets to the canine and incisor teeth, below which it lies.

branch to lower lip. *d.* The *mental* or *labial branch* which issues on the face beneath the depressor of the angle of the mouth has been described on page 564.

Dental artery has an The INFERIOR DENTAL ARTERY, after entering the lower jaw, has a similar course and distribution to the nerve. Thus it supplies offsets to the bone, dental branches to the molar and bicuspid teeth, and ends anteriorly in an incisor and a mental branch.

incisor and The *incisor branch* is continued to the symphysis of the jaw, where it ends in the bone; it furnishes twigs to the canine and incisor teeth.

labial branch. The *mental branch*, issuing by the mental foramen, ramifies in the structures covering the lower jaw, and anastomoses with the branches of the facial artery.

Lingual nerve The LINGUAL OR GUSTATORY NERVE (8) is concealed at first, like the others, by the external pterygoid muscle. It is then inclined

courses to the tongue; forwards with a small artery over the internal pterygoid, and under cover of the side of the jaw to the tongue. The remainder of the nerve will be seen in the dissection of the submaxillary region (p. 623).

no branch here. In its course beneath the jaw the nerve does not give off any branches, but the following communicating nerve is received by it.

Chorda tympani joins lingual, The *chorda tympani* (6) is a branch of the facial nerve, and leaves the tympanum by a special aperture close to the inner end of the Glaserian fissure. Appearing from beneath the upper

ttachment of the internal lateral ligament of the jaw, this small nerve joins the lingual at an acute angle, about three-quarters of n inch below the skull. At the point of meeting a communi- ation takes place with the lingual, but the greater part of the horda tympani is merely conducted along that nerve to the ongue. ends in tongue.

The origin of this nerve, and its course across the tympanum, will be described in Chapter XII.

The *nerve to the internal pterygoid* can now be seen as it passes beneath the hinder border to the inner surface of its muscle, but it will be more fully shown in the dissection of the otic ganglion. Branch to internal pterygoid.

Section VIII.

SUBMAXILLARY REGION.

The submaxillary region is situate between the lower jaw and the hyoid bone. In it are contained some of the muscles of the hyoid bone and tongue, the vessels and nerves of the tongue, and the sublingual and submaxillary glands. Parts in it.

Position. In this dissection the position of the neck is the same as for the examination of the anterior triangle. Position of the neck.

Dissection. If any fatty tissue has been left on the submaxillary gland, or on the mylo-hyoid muscle, when the anterior triangular space was dissected, let it be taken away. Dissection.

The SUBMAXILLARY GLAND (fig. 213, [11], p. 589) lies below the jaw in the anterior part of the space limited by that bone and the digastric muscle. Somewhat oval in shape, it rests on the mylo-hyoid, and sends a deep process round the posterior or free border of that muscle. In front of it is the anterior belly of the digastric; and behind is the stylo-maxillary ligament separating it from the parotid. The gland is covered only by the integuments, platysma, and deep fascia; and the facial artery winds forwards on its deep surface. Submaxillary gland; situation and relations;

In structure the submaxillary resembles the parotid gland and its duct—duct of Wharton—issuing from the deep process, extends beneath the mylo-hyoid muscle to the mouth. structure and duct.

Dissection. To see the mylo-hyoid muscle, detach the anterior belly of the digastric from the jaw, and dislodge without injury the submaxillary gland from beneath the bone. Dissection.

The MYLO-HYOID MUSCLE is triangular in shape, with the base at the jaw and the truncated apex at the hyoid bone, and unites along the middle line with its fellow of the opposite side. It *arises* from the mylo-hyoid ridge on the inner surface of the lower jaw as far back as the last molar tooth; and its posterior fibres, including about a third of the muscle, are *inserted* into the front of the body of the hyoid bone, whilst the remainder blend with those of the muscle of Mylo-hyoid arises from jaw; inserted into hyoid bone and raphé;

the opposite side, in a median raphé between the hyoid bone and the jaw.

parts around it ; On the cutaneous surface lie the anterior belly of the digastric muscle and the submaxillary gland, the facial artery with its submental offset, and the mylo-hyoid nerve and artery. The fibres of the muscle are frequently deficient near the jaw, and allow the genio-hyoid to be seen. Only the posterior border is unattached, and round it a piece of the submaxillary gland winds. The parts in contact with the deep surface of the muscle will be shown after the undermentioned dissection has been made.

use. *Action.* The mylo-hyoid assists the digastric and genio-hyoid in depressing the lower jaw or in elevating the hyoid bone ; but its principal action is to raise the floor of the mouth and press the tongue against the palate, as in the first stage of deglutition.

Dissection to detach mylo-hyoid. **Dissection.** To bring into view the muscles beneath the mylo-hyoid, and to trace the vessels and nerves to the substance of the tongue, the student should first divide the facial vessels on the jaw, and remove them with the superficial part of the submaxillary gland ; but he should be careful to leave the deep part of the gland which turns beneath the mylo-hyoid, because the small submaxillary ganglion is in contact with it. Next he should cut through the small branches of vessels and nerve on the surface of the mylo-hyoid ; and detaching that muscle from the jaw, should turn it down (as in fig. 224, p. 624), but without injuring the genio-hyoid muscle beneath it.

To see deep muscles saw the jaw, Afterwards the bone is to be sawn through at the symphysis, without injuring the muscles beneath it, the soft parts covering the jaw having been first cut. The loose ramus of the jaw (for it has been sawn in the dissection of the pterygoid region) is to be raised to see the parts beneath, and it may be fastened up with a stitch ; but it should not be detached from the mucous membrane of the mouth.

fasten tongue, The apex of the tongue is now to be well pulled out of the mouth over the upper teeth, and fastened with a stitch to the septum of the nose, and the scalpel should be passed from below upwards between

and cut mucous membrane. the sawn surfaces of the bone, for the purpose of dividing a strong band of the mucous membrane of the mouth ; and it should be carried onwards along the middle line of the tongue to the tip.

Define nerves, By means of a stitch the hyoid bone may be fastened down, to make tight the muscular fibres. All the fat and areolar tissue covering the parts under cover of the jaw are to be removed, and in doing this the student is to take care of the Whartonian duct, of the hypo-glossal nerve and its branches, which lie on the hypo-glossus muscle, and especially of its small offset ascending to the stylo-glossus muscle ; also of the lingual nerve nearer the jaw. Between the lingual nerve and the deep part of the submaxillary gland the dissector should seek the small submaxillary ganglion with its offsets ; and he should endeavour to separate from the trunk of the lingual the small chorda tympani nerve, and to define the offset from it to the submaxillary ganglion.

At the hinder border of the hyo-glossus clean the lingual vessels, the stylo-hyoid ligament, and the glosso-pharyngeal nerve, all passing beneath that muscle; and at the anterior border find the issuing ranine artery, which, with the companion vein and lingual nerve, is to be traced on the under surface of the tongue to the tip. vessels,

Adhering to the mucous membrane of the mouth is the sublingual gland, and this is to be defined, together with the sublingual artery which supplies it. and sublingual gland.

Parts beneath the mylo-hyoid (fig. 224). The relative position of the objects covered by the mylo-hyoid is now apparent:—Extending from the hyoid bone to the side of the tongue is the hyo-glossus muscle, the fibres of which are crossed superiorly by those of the stylo-glossus. On the hyo-glossus are placed, from below upwards, the hypoglossal nerve, Wharton's duct, and the lingual nerve, the latter crossing the duct; and near the anterior border of the muscle the two nerves are united by branches. Beneath the same muscle lie, from below upwards, the lingual artery, the stylo-hyoid ligament, and the glosso-pharyngeal nerve. Above the hyo-glossus is the mucous membrane of the mouth, with the sublingual gland attached to it in front, and some fibres of the superior constrictor muscle covering it behind near the jaw. Parts beneath mylo-hyoid; above hyoid bone,

Between the chin and the hyoid bone, close to the middle line, is situate the genio-hyoid muscle; above this is a larger fan-shaped muscle, the genio-glossus. Along the outer side of the last muscle lie the ranine vessels; and a sublingual branch for the gland of the same name springs from the lingual artery at the anterior border of the hyo-glossus. On the under surface of the tongue, near the margin, lies the lingual nerve; and the hypoglossal nerve enters the fibres of the genio-glossus. in front of hyo-glossus.

The HYO-GLOSSUS MUSCLE (fig. 223, 1, p. 622, and fig. 222, c), is thin and somewhat square in shape. It *arises* from the lateral part of the body, and from all the great cornu, of the hyoid bone. The fibres ascend and enter the side of the tongue, extending from the base to the tip, and they will afterwards be seen to mingle with those of the palato- and stylo-glossus.* Hyo-glossus:

The parts lying on the outer surface of the hyo-glossus, as well as those passing beneath its anterior and posterior borders, have already been enumerated; and under the muscle there are also portions of the genio-glossus and middle constrictor. parts in contact;

Action. This muscle depresses the tongue, drawing down the sides and giving a rounded form to the dorsum; and if the tongue be protruded from the mouth, the fibres will draw it backwards into that cavity. use.

The STYLO-GLOSSUS (223, 2) is a slender muscle, which *arises* from Stylo-glossus

* A distinct muscular slip (chondro-glossus), arising from the small cornu of the hyoid bone, is sometimes regarded as a part of the hyo-glossus. For farther details respecting the anatomy of this and the other lingual muscles, reference should be made to the Section on the Tongue.

the styloid process near the apex, and from the stylo-maxillary ligament, and is directed downwards and forwards to the hinder part of the lateral margin of the tongue. Here it gives some fibres to the dorsum, but the greater part of the muscle turns to the under surface, and is continued forwards to the tip of the tongue. Beneath the jaw this muscle is crossed by the lingual nerve.

comes to side of tongue;

Action. Both muscles will raise the back of the tongue against the roof of the mouth; and if the tongue be protruded they will restore it to the cavity.

use of both,

One muscle can direct the point of the tongue towards its own side of the mouth.

of one.

The GENIO-HYOID MUSCLE (fig. 223, 4) *arises* from the lower of the mental spines on the inner aspect of the symphysis of the jaw, and is *inserted* into the front of the body of the hyoid bone.

Genio-hyoid:

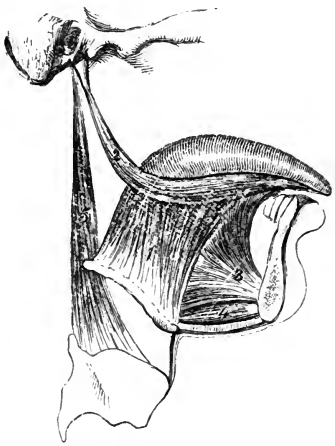


Fig. 223.—Muscles of the Tongue.

1. Hyo-glossus.
2. Stylo-glossus.
3. Genio-glossus.
4. Genio-hyoid.
5. Stylo-pharyngeus.

The lower surface of this muscle is covered by the mylo-hyoid, and the upper is in contact with the genio-glossus (3). The inner border touches the muscle of the opposite side, and the two are often united.

relations;

Action. The genio-hyoid either depresses the lower jaw or raises the hyoid bone, according to which end is fixed by other muscles.

use.

The GENIO-GLOSSUS (genio-hyo-glossus, fig. 223, 3, and fig. 224, A) is a thick, fan-shaped muscle, having its apex at the jaw, and its base at the tongue. It takes *origin* from the upper of the mental spines behind the symphysis of the jaw. From this spot the fibres radiate, the posterior passing backwards to their *insertion* into the body of the hyoid bone, the anterior forwards to the tip of the tongue, and the intermediate ones to the tongue from the base to the tip.

Genio-glossus:

origin:

insertion;

Lying close to the median plane, the inner surface of the muscle is in contact with its fellow. Its lower border corresponds to the genio-hyoid, and the upper to the frænum linguæ. On its outer side are the ranine vessels, and the hyo-glossus muscle; and the hypoglossal nerve perforates the hinder fibres.

contiguous parts;

Action. By the simultaneous action of the whole muscle the tongue is depressed, and hollowed along the middle. The hinder

use.

fibres acting alone raise the hyoid bone and protrude the tongue; while the anterior retract the tip of the tongue.

The LINGUAL ARTERY (fig. 217, *f*, p. 603) arises from the external carotid opposite the great cornu of the hyoid bone. At first it is directed forwards above the hyoid bone, and then upwards beneath the hyo-glossus to the under part of the tongue (fig. 224); it ends at the anterior border of that muscle in the sublingual and ranine branches. Before it reaches the hyo-glossus, the artery forms a small loop, with its convexity upwards, which is crossed by the hypoglossal nerve; and the digastric and stylo-hyoid muscles also lie over the vessel, but are separated from it by the hyo-glossus. The trunk rests on the middle constrictor and genio-glossus muscles. Its *branches* are :— Lingual artery ascends to the tongue beneath hyo-glossus.

a. A small *hyoid branch* is distributed to the muscles at the upper border of the hyoid bone; it anastomoses with its fellow of the opposite side, and with the hyoid branch of the superior thyroid artery of the same side. Its branches are— to hyoid bone;

b. The *dorsalis linguæ* branch arises beneath the hyo-glossus muscle, and ascends to supply the dorsal part of the substance of the tongue and the tonsil. The fibres of the hyo-glossus must be divided to see it. to back of the tongue;

c. The *sublingual branch* springs from the final division of the artery at the edge of the hyo-glossus, and is directed outwards to the gland of the same name. Some offsets supply the gums and the contiguous muscles, and one continues behind the incisor teeth to join a similar artery from the other side. to the sublingual gland;

d. The *ranine branch* (fig. 224, 9) is the terminal part of the lingual artery, and extends forwards along the outer side of the genio-glossus to the tip of the tongue where it ends. Muscular offsets are furnished to the substance of the tongue of the same side. This artery is very tortuous, and is embedded in the muscular fibres of the tongue. to the substance of tongue.

The lingual artery is accompanied by two small *venæ comites*, but the largest vein of the tongue is the *ranine*, which lies external to the artery of the same name, and, after being joined by *sublingual branches*, passes backwards over the hyo-glossus muscle with the hypoglossal nerve. These veins end in the internal jugular. Lingual veins.

The LINGUAL NERVE (fig. 224, 1) has been followed in the pterygo-maxillary region to its passage between the ramus of the lower jaw and the internal pterygoid muscle (p. 618). In the submaxillary region the nerve is inclined inwards to the side of the tongue, across the mucous membrane of the mouth and the origin of the superior constrictor muscle, and above the deep part of the submaxillary gland. Lastly it is directed forwards below the Whartonian duct, and along the side of the tongue to the apex. *Branches* are furnished to the surrounding parts, thus :— Lingual nerve along side of tongue gives branches

Two or more offsets connect it with the submaxillary ganglion, near the gland of that name. to the ganglion,

Further forwards one or more branches descend on the hyo-glossus to unite in a loop with twigs of the hypoglossal nerve. to twelfth nerve,

to mucous membrane,

Other filaments are supplied to the mucous membrane of the mouth, the gums, and the sublingual gland.

to the papillæ.

Lastly, the *branches for the tongue* ascend through the muscular substance, and are distributed to the conical and fungiform papillæ.

Submaxillary ganglion

The SUBMAXILLARY GANGLION (fig. 224, 2) resembles the other ganglia connected with the three trunks of the fifth nerve, and communicates with motor, sensory, and sympathetic nerve. It lies on the hyo-glossus muscle immediately above the deep part of the

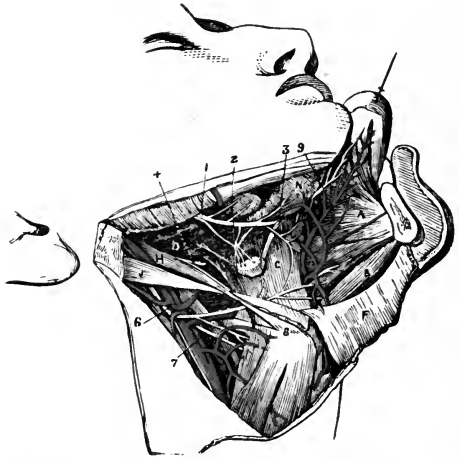


FIG. 224.—DEEP VIEW OF THE SUBMAXILLARY REGION (ILLUSTRATIONS OF DISSECTIONS).

Muscles :

A. Genio-glossus.
B. Genio hyoid.
C. Hyo-glossus.
D. Stylo-glossus.
F. Mylo-hyoid reflected.
H. Stylo-hyoid.
J. Posterior belly of digastric.

Nerves :

1. Lingual.
2. Submaxillary ganglion.
4. Glosso-pharyngeal.
6. Hypoglossal.
7. Upper laryngeal. The lingual artery is seen dividing, close to the hypoglossal nerve : the ranine offset is marked with 9.
3. Wharton's duct.

submaxillary gland, and is attached by two or three filaments to the lingual nerve.

has roots from the fifth, facial and sympathetic;

Connection with nerves—roots. The fibres of the sensory root are derived from the lingual, and of the motor root from the chorda tympani nerves, both joining the upper part of the ganglion. The sympathetic root comes from the plexus on the facial artery.

gives branches to gland.

Branches. From the lower part of the ganglion five or six small offsets descend to the submaxillary gland; and from the fore part other filaments are given to the mucous membrane of the mouth and to Wharton's duct.

Chorda tympani: destination.

CHORDA TYMPANI. Joining the lingual nerve close below its origin (p. 618), the chorda tympani accompanies that trunk, but can be easily separated from it nearly as far as the tongue. Beyond that point its fibres are mixed with those of the lingual nerve. Near the submaxillary gland, an offset is sent to the submaxillary ganglion.

Twelfth nerve above hyoid bone.

The HYPOGLOSSAL or TWELFTH nerve in the submaxillary region is directed forwards across the lower part of the hyo-glossus muscle, and under cover of the mylo-hyoid. At the anterior border of the hyo-glossus it enters the fibres of the genio-glossus, spreading out and dividing into numerous branches as it disappears.

Its branches supply muscles of tongue.

Branches. While resting on the hyo-glossus, the twelfth nerve furnishes offsets to the stylo-glossus, hyo-glossus and genio-hyoid* muscles, as well as one or two communicating filaments to the lingual nerve. Its terminal branches, within the genio-glossus, supply that muscle and the intrinsic muscles of the tongue. The lingual branches are long and slender, and some of them may be traced forwards to the tip of the tongue.

The GLOSSO-PHARYNGEAL nerve (fig. 224, 4), appearing between the two carotid arteries, courses forwards over the stylo-pharyngeus, and ends under the hyo-glossus in branches for the tongue. (See the DISSECTION OF THE TONGUE, p. 688).

Wharton's duct

The *duct of the submaxillary gland* (fig. 224, 3), Wharton's duct, issues from the deep part of the glandular mass turning round the border of the mylo-hyoid muscle. About two inches in length, it is directed upwards and forwards on the hyo-glossus muscle, and over the lingual nerve, to open on the centre of an eminence by the side of the frænum linguæ: the opening in the mouth will be seen if a bristle be passed along the duct. The deep part of the submaxillary gland extends along the side of the duct, reaching, in some instances, the sublingual gland.

opens by frænum linguæ.

Sublingual gland

The SUBLINGUAL GLAND (fig. 224, N) is an almond-shaped body with its longest diameter, which measures about an inch and a half, directed from before backwards. It lies beneath the fore part of the tongue, between the genio-glossus muscle and the lower jaw, and resting on the mylo-hyoid. Its upper border is covered by mucous membrane, which is raised into a fold along the floor of the mouth over the gland; and its inner end touches the one of the opposite side behind the symphysis of the jaw.

forms a prominence below tongue,

and is a composite structure.

The gland consists of from ten to twenty small masses, each of which has a separate duct. The ducts (ducts of Rivinus) open for the most part on the sublingual mucous fold, but some of them join the submaxillary duct, and one larger tube (duct of Bartholin), which is, however, frequently wanting, springs from the deeper part of the gland and runs forward to end either in common with, or close to, the duct of Wharton.

* The branch to the genio-hyoid muscle is composed of fibres derived from the cervical nerves. Compare note on p. 602.

Section IX.

DEEP VESSELS AND NERVES OF THE NECK.

Parts in this section.

In this Section are included the deepest styloid muscle, the internal carotid and ascending pharyngeal arteries, and some cranial and sympathetic nerves.

Position of head.

Position. The position of the part is to remain as before, viz., the neck is to be fixed over a small block.

Dissection of the stylo-pharyngeus,

Dissection. To see the stylo-pharyngeus muscle, the posterior belly of the digastric and the stylo-hyoid muscle should be detached from their origin and thrown down. The trunk of the external carotid artery is to be removed by cutting it through where the hypoglossal nerve crosses it, and by dividing those branches that have been already examined : any veins accompanying the arteries are to be taken away. While cleaning the surface of the stylo-

and glosso-pharyngeal nerve.

pharyngeus muscle, the glosso-pharyngeal nerve and its branches, and the stylo-hyoid ligament are also to be prepared. The side of the jaw is to be drawn forwards on the face.

Stylo-pharyngeus: origin ;

The Stylo-pharyngeus muscle (fig. 622, [5], p. 622), resembles the other styloid muscles in its elongated form. The fibres *arise* from the root of the styloid process on the inner side, and descend between the superior and middle constrictors to be *inserted* partly into the wall

insertion ;

of the pharynx, and partly into the upper and hinder borders of the thyroid cartilage.

is between carotid arteries:

The muscle lies below the stylo-glossus, and between the two carotid arteries ; and the glosso-pharyngeal nerve turns over the lower end of its fleshy belly.

use.

Action. It raises the pharynx, and tends to dilate the part of the cavity above the hyoid bone. From its attachment to the thyroid cartilage it will assist in elevating and drawing backwards the larynx.

Stylo-hyoid ligament

The *stylo-hyoid ligament* is a slender fibrous band, which extends from the tip of the styloid process to the small cornu of the hyoid

lies by side of preceding.

bone. Its position is between the stylo-glossus and stylo-pharyngeus muscles, and over the internal carotid artery ; while the lower end is placed beneath the hyo-glossus muscle. To its posterior border, the middle constrictor muscle is attached below. It is frequently cartilaginous or osseous in part of, or occasionally in all its extent. Sometimes a slip of fleshy fibres is continued along it.

Internal carotid artery.

The internal carotid artery supplies the deep parts of the head, viz., the brain, the contents of the orbit, and the nose ; and takes a circuitous course through and along the base of the skull before it ends in branches to the cerebrum.

Part already seen.

The arterial trunk in the cranium has been already learnt, and its ophthalmic offset will be seen in the dissection of the orbit ; but the

portion in the neck and the temporal bone remain to be dissected. The terminal branches of the carotid are examined with the brain.

Dissection (fig. 225, p. 628). For the display of the cervical part of the artery there is now but little dissection required. By detaching the styloid process at the root, and throwing it forward with its muscles, the internal carotid artery and the jugular vein may be followed upwards to the skull. Only a dense fascia conceals them; and this is to be taken away carefully, so that the branches of the nerves may not be injured. Dissection of carotid in the neck;

In the fascia, and directed forwards over the artery, seek the glosso-pharyngeal nerve, and its branches near the skull, and the small pharyngeal branch of the vagus lower down; still lower, the superior laryngeal branch of the vagus, with its external laryngeal offset, crossing beneath the carotid. Between the vein and artery, close to the skull, will be found the vagus, hypoglossal, and sympathetic nerves: and crossing backwards, over or under the vein, the spinal accessory nerve. External to the vessels the loop of the first and second cervical nerves over the transverse process of the atlas is to be defined; and from it branches of communication are to be traced to the large ganglion of the sympathetic beneath the artery, and to the vagus and hypoglossal nerves. The dissection of these nerves from the carotid vessels at the base of the skull is a difficult operation in consequence of the strong investing tissue. Ascending to the cranium, on the inner side of the carotid, the ascending pharyngeal artery will be met with. and of the cranial nerves;

The INTERNAL CAROTID ARTERY (fig. 225, *d*) springs from the bifurcation of the common carotid trunk. It extends from the upper border of the thyroid cartilage to the base of the skull; then through the petrous portion of the temporal bone; and lastly along the base of the skull to the anterior clinoid process, where it ends in branches for the brain. This winding course of the artery may be divided into three portions—one in the neck, another in the temporal bone, and a third in the cranium. Internal carotid. enters the skull. Its course is first

Cervical part. In the neck the artery ascends almost vertically from its origin to the carotid canal, and is in contact with the pharynx on the inner side. The line of the common carotid artery would mark its position in the neck. Its depth from the surface varies like that of the external carotid; and the digastric muscle may be taken as the index in this difference. Thus, below that muscle, the internal carotid is overlapped by the sterno-mastoid and covered by the common integuments, fascia, and platysma, and is on the same level as the external carotid, though farther back. But above that muscle, the vessel is placed deeply beneath the external carotid artery and the parotid gland, and is crossed by the styloid process and the stylo-pharyngeus muscle. While in the neck, the internal carotid lies on the rectus capitis anticus major muscle, which separates it from the vertebræ. through the neck; less deep below, but very deep above; rests on rectus.

Vein. The internal jugular vein accompanies the artery, being contained in a sheath with it and placed on its outer side. Position of vein,

of vessels, *Small vessels.* Below the digastric muscle the occipital artery is directed back over the carotid; and the offset from it to the sterno-

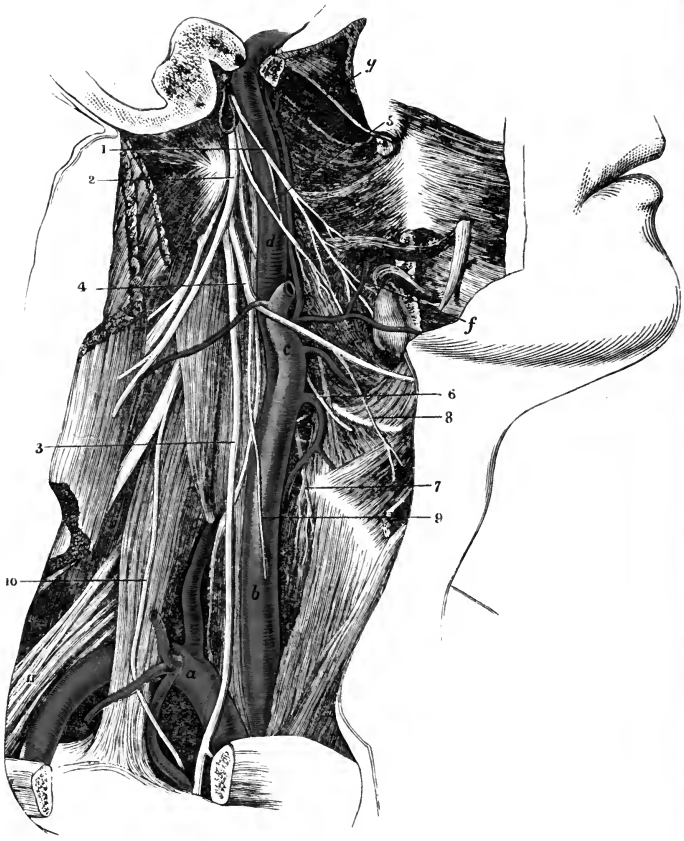


FIG. 225.—DEEP VESSELS AND NERVES OF THE NECK (ILLUSTRATIONS OF DISSECTIONS).

Arteries:

a. Subclavian.
b. Common carotid.
c. External carotid, cut.
d. Internal carotid.
f. Inferior palatine branch of facial.
g. Ascending pharyngeal.

Nerves:

1. Glosso-pharyngeal.
2. Spinal accessory.
3. Pneumo-gastric or vagus.
4. Hypoglossal.
5. Pharyngeal branch of vagus.
6. Superior laryngeal branch of vagus.
7. External laryngeal branch of the last.
8. Thyro-hyoid branch of hypoglossal.
9. Descendens cervicis, cut.
10. Phrenic.
11. Brachial plexus. Recurrent of the vagus winds round the subclavian artery, *a*.

mastoid may run down on the carotid trunk. Above the digastric the posterior auricular artery crosses the internal carotid.

Nerves. The pneumo-gastric is contained in the sheath at the back between the artery and vein, being parallel to them; and the sympathetic, also running longitudinally, lies behind the sheath of the vessels. Crossing the artery superficially, from below upwards, are the hypoglossal, which sends its descending branch downwards along the vessel; next the pharyngeal branch of the vagus; and lastly the glosso-pharyngeal. Directed inwards beneath the carotid are the pharyngeal offsets of the upper ganglion of the sympathetic and the superior laryngeal nerve, the latter furnishing the external laryngeal branch. Close to the skull, the cranial nerves of the neck are interposed between the artery and the vein. Around the carotid entwine branches of the sympathetic and offsets of the glosso-pharyngeal nerve. of nerves.

The cervical portion of the artery remains much the same in size to the end, though it is sometimes very tortuous; and it usually does not furnish any branch.

The PART IN THE TEMPORAL BONE is described on page 682.

The INTERNAL JUGULAR VEIN is continuous with the lateral sinus of the skull, and extends from the jugular foramen nearly to the first rib. Behind the inner end of the clavicle it joins the subclavian to form the innominate vein. Internal jugular vein; joins subclavian;

As far as the thyroid cartilage the vein accompanies the internal carotid, but below that point it is the companion to the common carotid artery; and it lies on the outer side of each. Its contiguity to the artery is not equally close throughout, for near the skull there is a small interval between them, containing the cranial nerves; and at the lower part of the neck there is a larger intervening space, in which the pneumo-gastric nerve, with its cardiac branch, is found. is outside carotids;

The size of the vein remains much the same from the skull to the hyoid bone, where it is suddenly increased owing to the junction of a number of tributaries corresponding to branches of the external carotid artery. Its lower dilatation and its valve have been before referred to (p. 601). enlarged below hyoid bone;

The following *tributaries* open into the internal jugular, viz., the inferior petrosal sinus close below the skull, the pharyngeal, lingual, facial and superior thyroid veins near the hyoid bone, and the middle thyroid vein opposite the lower part of the larynx. branches

The ASCENDING PHARYNGEAL ARTERY (fig. 225, *g*) is a long slender branch of the external carotid, which arises near the beginning of that vessel. It runs upwards between the internal carotid artery and the pharynx to near the base of the skull, where it ends in pharyngeal and meningeal branches. Its offsets are numerous, but small:— Ascending pharyngeal artery; ends at skull:

a. Prevertebral branches pass to the longus colli and recti antici muscles, supplying also the nerves and lymphatic glands of this region. branches are prevertebral,

b. Pharyngeal branches supply the wall of the pharynx, the soft palate and the tonsil. The highest of these, one of the terminal branches of the artery, ramifies in the superior constrictor, the Eustachian tube, and the levator and tensor palati muscles: this pharyngeal,

branch is sometimes large and furnishes the inferior palatine artery instead of the facial.

and meningeal.

c. Small *meningeal branches* enter the skull through the foramen lacerum, the jugular foramen and the anterior condylar foramen. These arteries are seldom injected.

The *pharyngeal veins* form a plexus which empties itself into the internal jugular trunk.

Directions concerning small branches of the nerves.

Dissection of the cranial nerves in the neck. By the time this stage of the dissection has been arrived at, the condition of the parts will not permit the tracing of the very minute filaments of the cranial nerves in the jugular foramen, and the parts described in the paragraphs marked with an asterisk cannot be seen at present. Afterwards, if a fresh piece of the skull can be obtained, in which the bone has been softened by acid and the nerves hardened in spirit, the examination of the branches marked thus * may be made.

Dissection to open jugular foramen.

* *In the jugular foramen.* Supposing the dissection of the internal carotid to be carried out as it is described at page 682, let the student cut across with care the jugular vein near the skull. Let him then remove bit by bit with the bone forceps, or with a scalpel if the part has been softened, the ring of bone which bounds externally the jugular foramen, proceeding as far forwards as the osseous crest between that foramen and the carotid canal. Between the bone and the coat of the jugular vein, the small auricular branch of the pneumo-gastric nerve is to be found; it is directed backwards to an aperture near the styloid process.

Follow spinal accessory and pneumo-gastric;

* Trace then the *spinal accessory* and *pneumo-gastric nerves* through the foramen, by opening the fibrous sheath around them. Two parts, large and small, of the spinal accessory nerve should be defined; the latter is to be shown joining a ganglion on the vagus, and applying itself to the trunk of that nerve. A communication between the two pieces of the spinal accessory is to be found. On the pneumo-gastric is a small well-marked ganglion (*ganglion of the root*), from which the auricular branch before referred to takes origin; and from the ganglion filaments are to be sought passing to the smaller portion of the spinal accessory nerve, and to the ascending branch of the upper cervical ganglion of the sympathetic.

afterwards glosso-pharyngeal

* Next follow *the glosso-pharyngeal nerve* through the fore part of the foramen, and take away any bone that overhangs it. This nerve presents *two ganglia* as it passes from the skull (fig. 226, p. 633); one (jugular), which is scarcely to be perceived, near the upper part of the tube of membrane containing it; the other, much larger (petrosal), is situate at the hinder border of the petrous portion of the temporal bone. From the lower one, seek the small nerve of Jacobson, which enters an aperture in the crest of bone between the jugular foramen and the carotid canal, and another filament of communication with the ganglion of the sympathetic. Sometimes the dissector will be able to find a filament from the lower ganglion to join the auricular branch of the pneumo-gastric, and another to end in the ganglion of the root of the pneumo-gastric nerve.

and its branches.

Below the foramen of exit from the skull, the cranial nerves have been for the most part denuded by the dissection of the internal carotid; but the intercommunications of the vagus, hypoglossal, sympathetic, and first two spinal nerves, near the skull, are to be traced out more completely. Dissection of the nerves in the neck:

The larger part of the spinal accessory has been sufficiently laid bare already; but its small part is to be traced to the vagus close to the skull, and onwards along that trunk. of spinal accessory;

The chief part of the glosso-pharyngeal has also been dissected; but the offsets on the carotid, and others to the pharynx in front of the artery are to be defined. of glosso-pharyngeal;

On the pneumo-gastric trunk the student will find an enlargement close to the skull (*ganglion of the trunk*), to which the hypoglossal nerve is intimately united. From the ganglion proceed two branches (pharyngeal and laryngeal), which are to be traced to the parts indicated by their names, especially the first which enters the pharyngeal plexus. The task of exposing the ramifications of the branch of the vagus, and those of the glosso-pharyngeal and sympathetic in the plexus, is by no means easy, in consequence of the dense tissue in which they are contained. Two or more cardiac offsets of the vagus, one at the upper and another at the lower part of the neck, may be recognised readily. Lastly, the dissector may prepare more fully the recurrent branch coursing up beneath the lower end of the common carotid; by removing the fat around it, offsets may be seen passing to the chest and the windpipe. of vagus; pharyngeal plexus, cardiac offsets, and recurrent;

Only the first, or the deep part of the hypoglossal nerve remains to be made ready for learning; its communications with the vagus, sympathetic, and the spinal nerve are to be shown. of hypoglossal;

A dissection for the sympathetic will be given farther on (p. 636); but its large ganglion near the skull (upper cervical) should be cleaned, and the branches from it to the pharyngeal plexus should be pursued beneath the carotid artery. of sympathetic in part.

The *ninth, tenth, and eleventh cranial nerves* (glosso-pharyngeal, pneumo-gastric, and spinal accessory) leave the cranium together by the jugular foramen, from which circumstance they were formerly grouped together as one nerve—the eighth nerve of Willis. Outside the skull the nerves take different directions to their destination; thus the glosso-pharyngeal is inclined forwards to the tongue and pharynx over the internal carotid artery; the spinal accessory backwards to the sterno-mastoid and trapezius muscles over the internal jugular vein; and the pneumo-gastric nerve descends to the viscera of the thorax and abdomen lying in the carotid sheath for a considerable distance. Ninth, tenth and eleventh nerves.

The GLOSSO-PHARYNGEAL NERVE (figs. 225, [1] and 226, [1]) is the smallest of the three trunks. In the jugular foramen it is placed somewhat in front of the other two, and lies in a groove in the hinder border of the petrous part of the temporal bone. In the aperture of exit the nerve is marked by two ganglionic swellings, the upper one being the jugular, and the lower the petrosal ganglion. Glosso-pharyngeal nerve has two ganglia in foramen.

Its upper and lower ganglion.

The *jugular ganglion* (fig. 226, [4]) is very small, and is situate at the upper end of the osseous groove containing the nerve. It includes only the outer fibres of the nerve, and is not always to be recognised. The *petrosal ganglion* ([5]) is much larger, and encloses all the fibrils of the nerve. Ovalish in form, it is placed in a hollow in the posterior border of the temporal bone; and from it spring the branches that unite the glosso-pharyngeal with other nerves.

In the neck courses to the tongue.

After the nerve has quitted the foramen, it comes forwards between the jugular vein and the carotid artery (fig. 225, [1]), and descends over the artery until it reaches the hinder border of the stylo-pharyngeus muscle. Then curving forwards, it becomes almost transverse in direction, crosses the stylo-pharyngeus, and finally passes beneath the hyo-glossus muscle, where it ends in branches to the tongue.

Branches to join with others, viz., sympathetic and vagus, facial and sympathetic.

The *branches* of the glosso-pharyngeal may be classed into those connecting it with other nerves at the base of the skull, and those distributed in the neck.

The *connecting branches* arise from the petrosal ganglion; and in this set is the tympanic nerve.

* A filament ascends from the sympathetic nerve in the neck to join the petrosal ganglion. Sometimes there is an offset from the ganglion to the auricular branch of the vagus, another to the upper ganglion of this nerve and a twig to join the branch of the facial to the posterior belly of the digastric.

* The *tympanic branch* (nerve of Jacobson; fig. 226, [6]) enters the aperture in the ridge of bone between the jugular and the carotid foramina, and ascends by a special canal to the inner wall of the tympanum: its distribution is given with the anatomy of the middle ear (page 812).

Distributed to pharynx, stylo-pharyngeus, tonsil, and tongue.

Branches for distribution. In the neck the branches are furnished chiefly to the pharynx and the tongue.

a. Pharyngeal branches. Two or three branches, arising from the glosso-pharyngeal nerve as it lies over the carotid artery, descend to join the pharyngeal branch of the vagus and take part in the formation of the pharyngeal plexus; and one or two smaller twigs penetrate the superior constrictor muscle.

b. A *muscular branch* enters the stylo-pharyngeus while the nerve is in contact with the muscle.

c. The *tonsillitic branches* supply the tonsil and the arches of the soft palate. On the former they end in a kind of plexus—circulus tonsillaris.

d. Lingual branches. The terminal branches of the nerve supply the hinder part of the tongue, in connection with which they are described (page 688).

Vagus nerve in jugular foramen, and in the neck,

The PNEUMO-GASTRIC OR VAGUS NERVE (figs. 225, [3] and 226, [2]) is the largest of the cranial nerves in the neck, and escapes through the jugular foramen in the same sheath of dura mater as the spinal accessory. In the foramen it has a distinct ganglion (gang. of the root), to which the smaller part of the spinal accessory nerve is connected.

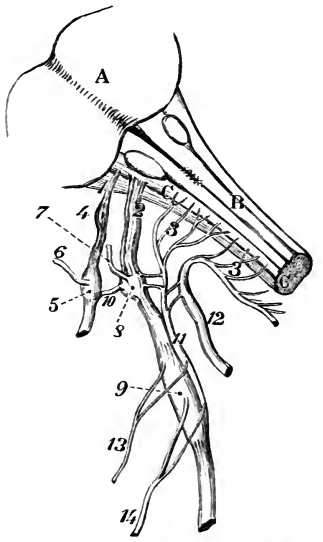
When the nerve has left the foramen, it receives the small part of

the spinal accessory, and swells into a ganglion nearly an inch long (gang. of the trunk). This ganglion lies between the internal carotid artery and jugular vein, and communicates with several nerves. To reach the thorax, the vagus descends almost vertically between the internal jugular vein and the internal and common carotid arteries; and it enters that cavity, on the right side, by crossing over the subclavian artery, but beneath the innominate vein.

courses to the thorax.

* The *ganglion of the root* (jugular ganglion; fig. 226, [8]) is of greyish colour, and from it small branches in the jugular foramen arise.

The *ganglion of the trunk* ([9]) is cylindrical in form, reddish in colour, and nearly an inch in length; it communicates with the hypoglossal, spinal, and sympathetic nerves. All the intrinsic fibres of the trunk of the nerve enter the ganglion, but those derived from the spinal accessory nerve ([11]) pass over the ganglion without being connected to it.



Its upper ganglion,

and lower ganglion.

Fig. 226.—Diagram of the Ninth, Tenth, and Eleventh Nerves.

A. Pons.
B. Medulla oblongata.
1. Glosso-pharyngeal nerve.
2. Vagus.
3, 3. Spinal accessory.
4. Jugular ganglion.
5. Petrosal ganglion.
6. Tympanic nerve.
7. Auricular branch.
8. Root-ganglion, and 9, Trunk-ganglion of vagus.
10. Branch joining the petrous and upper ganglion of the vagus.
11. Small part of spinal accessory.
12. Large part of spinal accessory.
13. Pharyngeal, and 14, superior laryngeal branch of vagus.

The *branches* of the pneumo-gastric nerve arising in the neck may be divided into those uniting it with other nerves, and those distributed to the several organs.

Branches to unite with others; auricular branch;

* *Connecting branches* (fig. 226) arise from the ganglia of the root and trunk of the vagus.

* *From the ganglion of the root.* The *auricular branch* (Arnold's nerve, [7]) is the chief offset, and crosses the jugular fossa to enter an aperture near the root of the styloid process; it traverses the substance of the temporal bone, and is distributed to the outer ear. Its farther course will be described with the anatomy of the ear (page 814).

* One or two short filaments unite this ganglion with the small part of the spinal accessory nerve; and a branch from the upper ganglion of the sympathetic enters it. Occasionally there is an offset ([10]) to join the petrosal ganglion of the glosso-pharyngeal nerve.

with eleventh, sympathetic, ninth; with

From the ganglion of the trunk. Communicating filaments pass

twelfth,

sympathetic, and spinal nerves.

between it and the hypoglossal nerve. Other branches connect it t the upper ganglion of the sympathetic and the loop of the first tw cervical nerves.

Branches of supply.

Branches for distribution. The cervical branches arise from th lower ganglion and the trunk of the nerve, and are directed inward to supply the pharynx, the larynx, and the heart.

To pharynx

a. The *pharyngeal branch* (fig. 225, 5) springs from the uppe part of the ganglion of the trunk, and is directed inwards over th internal carotid artery to the side of the pharynx, being joined i its course by the descending pharyngeal branches of the glosso pharyngeal nerve. On the surface of the middle constrictor, th

through pharyngeal plexus.

ramifications of the united nerves communicate freely together and with the pharyngeal branches of the sympathetic, form th *pharyngeal plexus.* The offsets of the plexus enter the wall of th pharynx and supply the constrictor muscles, the palato-glossus palato-pharyngeus, levator palati and azygos uvulæ muscles, an the mucous membrane between the mouth and the larynx.

Upper branch to larynx:

b. The *superior laryngeal nerve* (fig. 225, 6) is much larger tha the preceding branch, and comes from the middle of the ganglion o the trunk. It runs obliquely downwards and forwards, passing on the inner side of the internal and external carotids, to the interva between the hyoid bone and the thyroid cartilage. Here it perforate the thyro-hyoid membrane, and divides into branches for the supply of the mucous membrane of the larynx (page 697). While beneath the internal carotid artery it furnishes the following offset :—

its external offset.

The *external laryngeal branch* (fig. 225, 7) descends on the inferio constrictor muscle to the side of the larynx, and then beneath the sterno-thyroid to the crico-thyroid muscle in which it ends. Near its origin it gives off a filament to join the upper cardiac branch of the sympathetic; and lower down it supplies twigs to the inferior constrictor muscle.

Branches to the heart, upper and lower.

c. Cardiac branches. One or two small cardiac nerves spring from the pneumo-gastric at the upper part of the neck, and join cardiac branches of the sympathetic. At the lower part of the neck, on each side, there is a large cardiac nerve which descends into the thorax :— the right one joins the deep nerves to the heart from the sympathetic ; and the left terminates in the superficial cardiac plexus.

Lower branch to larynx

d. The *inferior* or *recurrent laryngeal nerve* leaves the pneumo-gastric trunk *on the right side* opposite the subclavian artery, and winding round that vessel, takes an upward course in the neck to the larynx, ascending beneath the common carotid artery, along the groove between the trachea and the œsophagus, and crossing either in front of or behind the inferior thyroid artery. At the larynx it enters beneath the ala of the thyroid cartilage, where it will be afterwards traced (page 697). The following branches arise from it :—

gives branches to heart,

Some *cardiac branches* leave the nerve as it turns round the subclavian artery ; these enter the thorax, and join the cardiac nerves of the sympathetic.

Tracheal and *œsophageal branches* spring from it as it ascends in the neck; and near the larynx some filaments are furnished to the inferior constrictor muscle. to trachea, œsophagus, and pharynx.

On the left side the recurrent nerve arises in the thorax, opposite the arch of the aorta; in the neck it lies between the trachea and œsophagus, as on the right side, and is more frequently behind the inferior thyroid artery. Left recurrent nerve.

The SPINAL ACCESSORY NERVE courses through the jugular foramen with the pneumo-gastric, but is not marked by any ganglion. The nerve is composed of two parts, a smaller one, accessory to the vagus, and a larger, spinal part, which have a different origin and distribution. Eleventh nerve has two parts.

The *part accessory to the vagus* (bulbar part; fig. 226,[11]) arises from the medulla oblongata, and ends by joining the pneumo-gastric outside the skull. In the foramen of exit it lies close to the vagus, and is connected to the upper ganglion of that nerve by one or two filaments. Below the foramen it passes over the lower ganglion of the vagus, and blends with the trunk beyond that ganglion. It gives distinct offsets to join the pharyngeal and superior laryngeal branches of the pneumo-gastric; and other fibres are continued into the cardiac and recurrent laryngeal branches. Accessory to vagus in foramen; below foramen.

The *spinal part* (fig. 226,[12]), which takes its origin from the spinal cord, is much larger, and is connected with the smaller piece while passing through the jugular foramen. Beyond the foramen the nerve (fig. 225,[2]) takes a backward course through the sterno-mastoid, and across the side of the neck to end in the trapezius: at first it is concealed by the jugular vein, but it then passes either over or under that vessel. The connections of the nerve beyond the sterno-mastoid have been already examined. Spinal part in foramen; in the neck crosses to trapezius,

The nerve furnishes muscular offsets to the sterno-mastoid and to the trapezius. supplies muscles.

The HYPOGLOSSAL NERVE, issuing from the cranium by the anterior condylar foramen, is at first deeply placed between the internal carotid artery and the jugular vein (fig. 225,[4]). It next comes forward between the vein and artery, turning round the outer side of the vagus to which it is closely united. The nerve now descends in the neck, and becomes superficial below the digastric muscle in the anterior triangular space (p. 602); from this spot it is directed forwards to the tongue and its muscles (p. 625). Twelfth nerve:

Connecting branches. Near the skull the hypoglossal is united to the lower ganglion of the vagus by filaments crossing between the two nerves as they are in contact. branches join it to vagus,

A little lower down the nerve is joined by offsets from the sympathetic and the loop of the first two spinal nerves. sympathetic, and spinal

The *branches for distribution* have been met with in the foregoing dissections. Thus, in the neck its descending branch supplies, in common with the spinal nerves, the depressors of the hyoid bone. In the submaxillary region it furnishes branches to one elevator (genio-hyoid) of the hyoid bone, to the extrinsic muscles of the nerves, and supply muscles.

tongue except the palato-glossus, and to all the intrinsic muscles of the tongue.

Dissection of rectus lateralis.

Dissection. The small rectus capitis lateralis muscle, between the transverse process of the atlas and the base of the skull, is now to be cleaned and learnt. At its inner border the anterior branch of the first cervical nerve, which forms a loop in front of the atlas, is to be found.

Rectus lateralis:

The RECTUS CAPITIS LATERALIS is very short, and represents a posterior intertransverse muscle. It *arises* from the fore and upper part of the transverse process of the atlas, and is *inserted* into the jugular process of the occipital bone.

parts around;

On the anterior surface rests the jugular vein; and in contact with the posterior are the obliquus superior muscle and the vertebral artery. To the inner side lie the anterior primary branch of the first cervical nerve and the rectus anticus minor muscle.

use.

Action. It assists the muscles attached to the mastoid process in inclining the head laterally.

Dissection of first nerve.

Dissection. For the purpose of tracing backwards the anterior branch of the first cervical nerve, divide the rectus lateralis muscle, observing the offset to it; then cut off the end of the transverse process of the atlas, and remove the vertebral artery, so as to bring into view the nerve as it lies on the first vertebra.

Anterior division of suboccipital nerve

The ANTERIOR PRIMARY BRANCH OF THE FIRST CERVICAL, or SUB-OCCIPITAL, NERVE is rather smaller than the posterior, and arises from the common trunk on the neural arch of the atlas. From that spot

lies on atlas

it is directed forwards above the transverse process, and on the inner side of the vertebral artery, to the interval between the rectus lateralis and rectus anticus minor muscles. Emerging here, it bends

forms a loop with second:

down in front of the transverse process of the atlas and forms a loop with the second cervical nerve. As the nerve passes forwards it supplies the rectus lateralis and anticus minor muscles, and

branches.

branches connect the loop with the vagus, hypoglossal and sympathetic nerves.

Sympathetic nerve in neck

SYMPATHETIC NERVE. In the neck the sympathetic nerve consists, on each side, of a gangliated cord, which lies close to the vertebral column, and is continued into the thorax. On this portion of the

has three ganglia.

nerve are *three ganglia*—the *superior* near the skull, the *middle* towards the lower part of the neck, and the *inferior* close to the first rib. From the ganglia proceed connecting branches to the spinal and most of the cranial nerves in the neck, and branches for distribution to viscera and blood-vessels.

Other ganglia on fifth nerve.

Besides the ganglia above mentioned, there are other ganglia in the head and neck, where the sympathetic enters into connection with the three divisions of the fifth nerve.

Dissection of upper ganglion;

Dissection. To display the branches of the sympathetic nerve greater care is necessary than in tracing the white-fibred nerves, for the sympathetic twigs are softer, more easily torn, and generally of smaller size. In the neck the ganglia and their branches have been partly prepared, and only the following additional dissection will be required

to bring them into view :—The jugular vein having been cut through, the upper ganglion will be seen by raising the carotid artery and the trunks of the vagus and hypo-glossal nerves, and by cutting through the branches that unite these two to the loop between the first and second spinal nerves. The several branches of the ganglion are to be traced upwards on the carotid artery, inwards to the pharynx, downwards along the neck, and outwards to other nerves.

The dissector has already seen the middle ganglion on or near the inferior thyroid artery, and its branches to spinal nerves, and along the neck, are now to be traced. of middle;

To obtain a view of the inferior ganglion the greater part of the first rib is to be taken away, and the subclavian artery is to be cut through, internal to the scalenus anticus, and drawn aside, without, however, destroying the fine nerves that pass over it. It is supposed that the clavicle has been removed. The ganglion is placed close above the neck of the first rib ; its branches are large, and are easily followed outwards to the vertebral artery and the spinal nerves, and downwards to the thorax. and inferior ganglion.

The SUPERIOR CERVICAL GANGLION is the largest of the three, and of a reddish-grey colour. Fusiform in shape, it is as long as the second and third cervical vertebræ, and is placed on the rectus capitis anticus major muscle, beneath the internal carotid artery and the contiguous cranial nerves. Branches connect the ganglion with other nerves ; and some are distributed to the blood-vessels, the pharynx, and the heart. Superior ganglion is near skull, beneath carotid.

Connecting branches unite the sympathetic with both the spinal and the cranial nerves. Connecting branches

With the spinal nerves. The four highest spinal nerves have branches of communication with the upper ganglion of the sympathetic ; but the offset to the fourth nerve may come from the cord connecting the upper to the next ganglion. with spinal nerves;

With the cranial nerves. Near the skull the lower ganglion of the vagus and the hypoglossal nerve are joined by branches of the sympathetic. Another offset from the upper part of the ganglion ascends to the jugular foramen, and divides into two filaments which join the petrosal ganglion of the glosso-pharyngeal and the root-ganglion of the vagus. with cranial below skull and in jugular foramen;

Communications are formed with several other cranial nerves by means of the ascending offset from the ganglion into the carotid canal (p. 518). and with some in the skull.

Branches for distribution. The branches of this set are more numerous than the preceding, and the nerves are generally of larger size. Branches.

The *ascending branch*, prolonged from the upper part of the ganglion, accompanies the internal carotid artery and its branches. Near the skull it divides into two pieces which enter the canal for the carotid, one on each side of that vessel, and are continued to the eyeball and the pia mater of the brain, forming secondary plexuses on the ophthalmic and cerebral arteries. In the carotid To internal carotid, which join cranial nerves;

canal communications are formed with the tympanic branch of the glosso-pharyngeal nerve, and with the spheno-palatine ganglion; with the former near the lower end, and with the latter near the upper opening of the canal. The communications and plexuses which these nerves form in their course to the brain are described at p. 518.

to external carotid, forming plexuses and ganglia; *Branches for blood-vessels* (nervi molles). These nerves surround the external carotid trunk, and ramify on its branches so as to form plexuses on the arteries with the same names as the vessels: some small ganglia are occasionally found on these slender nerves. By means of the plexus on the facial artery the *submaxillary ganglion* communicates with the sympathetic; and through the plexus on the internal maxillary artery the *otic ganglion* obtains a similar communication.

to pharyngeal plexus; The *pharyngeal nerves* pass inwards to the side of the pharynx, where they join with the branches of the glosso-pharyngeal and pneumo-gastric nerves in the pharyngeal plexus.

to cardiac plexuses; *Cardiac nerves* enter the thorax to join in the plexuses of the heart. There are three cardiac nerves on each side, viz., superior, middle, and inferior, each taking its name from the ganglion of which it is an offset.

superficial cardiac nerve. The *superior* or *superficial cardiac nerve* of the right side courses behind the sheath of the carotid vessels, and enters the thorax along the innominate artery. In the neck the nerve is connected with the cardiac branch of the vagus, with the external laryngeal, and with the recurrent nerve. In some bodies it ends by joining one of the other cardiac nerves.

Middle ganglion The MIDDLE CERVICAL OR THYROID GANGLION is of small size, and is situate beneath the great vessels, usually opposite the sixth cervical vertebra, on or near the inferior thyroid artery. Its branches are the following:—

joined to spinal nerves; *Connecting branches* with the spinal nerves sink between the borders of the longus colli and anterior scalenus to join the fifth and sixth cervical nerves.

loop to lower ganglion; A considerable branch passes between the middle and inferior cervical ganglia, forming a loop (ansa Vieussenii) over the front of the subclavian artery, and supplying it with filaments.

branches of distribution, *Branches for distribution.* These consist of nerves to the thyroid body, together with the middle cardiac nerve.

thyroid branches, The *thyroid branches* ramify around the inferior thyroid artery, and end in the thyroid body; they join the external and recurrent laryngeal nerves.

middle cardiac nerve The *middle* or *great cardiac nerve* descends to the thorax across the subclavian artery; its termination in the cardiac plexus has been learnt in the chest (p. 473). In the neck it communicates with the upper cardiac and recurrent laryngeal nerves.

Inferior ganglion The INFERIOR CERVICAL GANGLION is of large size, but irregular in shape, and lies over the interval between the first rib and the transverse process of the last cervical vertebra, its position being

nternal to the superior intercostal artery. Oftentimes it extends in front of the neck of the rib, and joins the first ganglion of the ord in the thorax. Its branches are similar to those of the other wo ganglia. on neck of first rib.

Connecting branches join the last two cervical nerves. Other nerves accompany the vertebral artery, forming the *vertebral plexus* around it, and communicating with the cervical nerves. Branches to spinal nerves and vertebral artery;

Only one branch for distribution, the *inferior cardiac nerve*, issues from the lower ganglion. It lies beneath the subclavian artery, joining in that position the recurrent laryngeal nerve, and enters the thorax to terminate in the deep cardiac plexus behind the arch of the aorta. and inferior cardiac.

DIRECTIONS. The student will now observe, so far as they are left, the structures in the upper opening of the thorax, and will then proceed to the dissection of the orbit whilst the skull is whole, in the meantime carefully wrapping up and treating with preservative the parts left in the neck. Directions.

PARTS IN THE UPPER APERTURE OF THE THORAX (fig. 171, p. 467). The relative position of the several parts entering or leaving the thorax by the upper opening may be now observed. Parts in the aperture of thorax.

In the middle line lie the remains of the thymus gland, and the trachea and œsophagus. In front of the trachea are the lower ends of the sterno-hyoid and sterno-thyroid muscles with layers of the cervical fascia, and the inferior thyroid veins; and behind the gullet and windpipe are the longi colli muscles. Between the two tubes is the recurrent nerve on the left side. In middle line.

On each side the dome of the pleura and the apex of the lung project into the neck; and in the interval between the pleura and the trachea and œsophagus, are placed the vessels and nerves passing between the thorax and the neck. Most anteriorly on both sides lie the innominate vein, the phrenic nerve, and the internal mammary artery; but the vessels and nerves next met with are different on the two sides:—On the right side are the innominate artery, with the vagus, the cardiac nerves and the right lymphatic duct. On the left side are the left vagus, the left common carotid artery, the thoracic duct and the left subclavian artery with the cardiac nerves. Lastly, altogether behind on each side are part of the first dorsal nerve, the cord of the sympathetic, and the superior intercostal artery. On each side: partly the same on both sides, and partly different.

SECTION X.

DISSECTION OF THE ORBIT.

Position. In the examination of this cavity the head is to be placed in the same position as for the dissection of the sinuses of the base of the skull. Position of the head.

Dissection. The cotton-wool beneath the eyelids should be taken away, and the bone forming the roof of the orbit may be removed in How to open the orbit with saw,

the following manner. Two cuts are to be made with the saw through the frontal bone, the inner one vertically over the internal margin of the anterior opening of the orbit, and the outer one, commencing behind the temporal crest, obliquely downwards and inwards, to the external angular process: then with a chisel these are to be continued backwards along the roof of the orbit, so as to meet near the optic foramen. The piece of bone included between the incisions is now to be tilted forwards, but is not to be taken away. This can be done by knocking forwards the piece of frontal bone between the saw-cuts with a mallet, and the orbital plate of the bone will be carried upwards from the periosteum beneath.

chisel,

and bone forceps.

Afterwards the rest of the roof of the orbit, which is formed by the small wing of the sphenoid bone, is to be cut away with the bone forceps, except a narrow ring around the optic foramen; and any overhanging bone, which may interfere with the dissection, should be likewise removed. During the examination of the cavity the eye is to be pulled gently forwards.

Periosteum of orbit.

The *periosteum* of the orbit is now seen where it has been detached from the bone in the dissection. This membrane forms a sac around the contents of the orbit which is continuous posteriorly with the dura mater through the sphenoidal fissure and the optic foramen, and is closed in front by the palpebral fascia passing from it to the lids. It adheres but loosely to the bones, and is perforated behind by apertures for the passage of the vessels and nerves entering the orbit. On the sides, prolongations of the membrane accompany the vessels and nerves leaving the cavity.

Open periosteum.

Dissection. The periosteum is next to be divided along the middle of the orbit, and to be taken away. After the removal of a little fat, the following nerves, vessels, and muscles come into view (fig. 227, p. 642); but it is not needful to remove much of the fat at this stage of the dissection.

Position of parts exposed.

The *frontal nerve* and the *supraorbital artery* are placed in the centre; the *lachrymal nerve and vessels* close to the outer wall; and the small *fourth nerve* at the back of the orbit: all these nerves are above the muscles in the cavity. The *superior oblique muscle* lies on the inner side, and is recognised by the fourth nerve entering its upper aspect; the *levator palpebræ* and *superior rectus* are beneath the frontal nerve; and the *external rectus* is partly seen below the lachrymal nerve. At the outer part of the orbit, near the front, is the *lachrymal gland*.

Trace superficial nerves.

The frontal and lachrymal nerves should be followed forwards to their exit from the orbit, and backwards, with the fourth nerve, through the sphenoidal fissure, to the wall of the cavernous sinus. In tracing them back, it will be expedient to remove the projecting anterior clinoid process, should this still remain; and some care will be required to follow the lachrymal nerve to its commencement.

Orbit has seven muscles;

Contents of the orbit. The eyeball, the lachrymal gland, and a quantity of granular fat, are lodged in the orbit. Connected with

the eye are six muscles—four straight and two oblique ; and there is also an elevator of the upper eyelid in the cavity.

The nerves in the cavity are numerous, viz., the second, third, fourth, ophthalmic of the fifth, and the sixth, together with the small temporo-malar branch of the superior maxillary nerve, and offsets of the sympathetic : their general distribution is as follows :—The second nerve enters the eyeball ; the third supplies all the muscles of the cavity but two ; the fourth enters the superior oblique ; and the sixth is spent in the external rectus muscle. The fifth nerve supplies some filaments to the eyeball with the sympathetic, but the greater number of its branches pass through the orbital cavity to the face. The ophthalmic vessels are also contained in the orbit.

several cranial nerves ; their distribution ; and some vessels.

The LACHRYMAL GLAND (fig. 227, F) secretes the tears, and is situate in the hollow on the inner side of the external angular process of the frontal bone. It is of an oval form, something like a small almond, and measures about three-quarters of an inch in its longest diameter, which is directed transversely. From its fore part a thin accessory piece projects beneath the upper eyelid. The upper surface is convex, and in contact with the periosteum, to which it is connected by fibrous bands that constitute a ligament for the gland ; the lower surface rests on the eyeball and the external rectus muscle.

Lachrymal gland at outer part of orbit.

The gland has from eight to twelve very fine ducts, which open on the surface of the conjunctiva in a curved line above the outer part of the upper eyelid, and a little in front of the fornix.

Ducts open behind upper eyelid.

The FOURTH NERVE (fig. 227, 1) is the most internal of the three nerves entering the orbit above the muscles. In the cavity, it is directed inwards above the levator palpebræ to the superior oblique muscle, which it pierces on the upper, or orbital surface.

Fourth nerve supplies superior oblique.

The OPHTHALMIC TRUNK of the fifth nerve as it approaches the sphenoidal fissure, furnishes from its inner side the nasal branch, and then divides into the frontal and lachrymal branches ; the first passes into the orbit between the heads of the external rectus, but the other two lie, as before said, above the muscles.

Ophthalmic gives three branches.

The *frontal nerve* (fig. 227, 2) is close to the outer side of the fourth as it enters the orbit, and is much larger than the lachrymal branch. In the course to the forehead the nerve lies along the middle of the orbit ; and after giving off from its inner side the *supratrochlear branch* (4), it leaves the cavity by the supraorbital notch. Taking the name *supraorbital*, it ascends on the forehead, where it is distributed. This nerve frequently divides into its two main branches (p. 504) while still within the orbit.

Frontal divides into supraorbital and supratrochlear.

While in the notch the supraorbital nerve gives one or two *palpebral* filaments to the upper lid.

Palpebral filaments.

The *supratrochlear nerve* (4) passes inwards above the pulley of the upper oblique muscle, and leaves the orbit to end in the eyelid and forehead (p. 504). Before the nerve turns round the margin of the frontal bone, it sends downwards a twig of communication to the infratrochlear branch of the nasal nerve.

Supratrochlear branch.

Lachrymal nerve

The *lachrymal nerve* (fig. 227, [3]) after entering the orbit in a separate canal of the dura mater, is directed forwards in the outer part of the cavity, and beneath the lachrymal gland in the upper

ends in eyelid:

eyelid, where it pierces the palpebral fascia, and is distributed to the structures of the lid.

offset joins superior maxillary.

The nerve furnishes branches to the lachrymal gland; and near

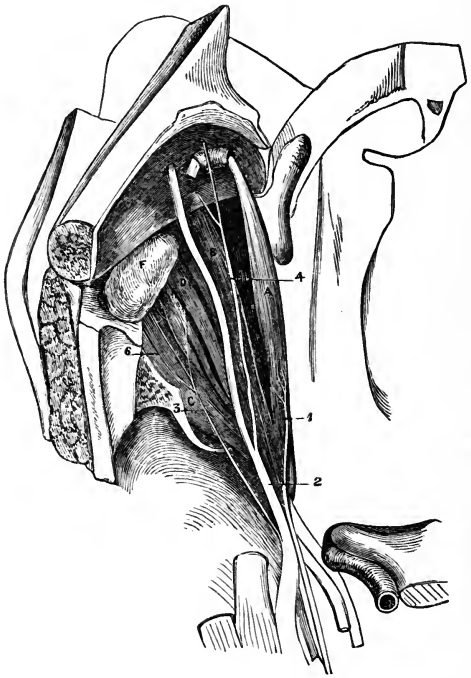


FIG. 227.—FIRST VIEW OF THE ORBIT (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Superior oblique.
B. Levator palpebræ.
C. External rectus.
D. Superior rectus.
F. Lachrymal gland.

Nerves:

1. Fourth.
2. Frontal.
3. Lachrymal.
4. Supratrochlear.
6. Offset of lachrymal to join temporo-malar.

the gland it sends downwards one or two small filaments ([6]) to join the temporo-malar branch of the superior maxillary nerve.

Nasal, afterwards.

The *nasal nerve* is not fully seen at this stage of the dissection, and will be noticed later (p. 644).

Dissection.

Dissection. Divide the frontal nerve about its middle, and throw the ends forwards and backwards: by raising the posterior piece of the nerve, the separate origin of the nasal branch from the

ophthalmic trunk will appear. The lachrymal nerve may remain uncut.

The LEVATOR PALPEBRÆ SUPERIORIS (fig. 227, B) is the most superficial muscle, and is *attached* posteriorly to the roof of the orbit in front of the optic foramen. The muscle widens in front, and bends downwards in the upper eyelid to be mainly *inserted* by a broad tendon into the front of the tarsal plate. Expansions from the tendon can be traced to the tissues over the eyebrow and at the root of the upper lid. Elevator of upper eyelid, attached to tarsus:

By one surface the muscle is in contact with the frontal nerve and the periosteum; and by the other with the superior rectus muscle. If it is cut across about the middle, a small branch of the third nerve will be seen entering the posterior half on the under surface. relations;

Action. The lid is made to glide upwards over the ball by this muscle, so that the upper edge is directed back and the lower forwards, the skin above the lid being folded inwards at the same time. use.

The SUPERIOR RECTUS (fig. 227, D) is the upper of four muscles that lie around the globe of the eye. It *arises* from the upper part of the optic foramen, and is connected with the other recti muscles around the optic nerve. In front the fleshy fibres end in a tendon, which is *inserted*, like the other recti, into the sclerotic coat of the eyeball about a quarter of an inch behind the transparent cornea. Upper rectus muscle: origin; insertion;

The under surface of the muscle is in contact with the globe of the eye, and with some vessels and nerves to be afterwards seen; the upper surface is partly covered by the preceding muscle. The action of the muscle will be given with the other recti (p. 650). position to other parts; use.

The SUPERIOR OBLIQUE MUSCLE (fig. 227, A) is thin and narrow, and passes through a fibro-cartilaginous loop at the inner angle of the orbit before reaching the eyeball. The muscle *arises* behind from the upper and inner part of the optic foramen, and ends anteriorly in a rounded tendon, which, after passing through the loop, or pulley, referred to, is reflected backwards and outwards between the superior rectus and the globe of the eye to be *inserted* into the sclerotic coat behind the middle of the ball. Upper oblique muscle traverses a pulley: insertion;

The fourth nerve is supplied to the orbital surface of the muscle and the nasal nerve lies below it. The thin insertion of the muscle lies between the superior and the external recti, and near the tendon of the inferior oblique. relations:

The *pulley*, or *trochlea* (fig. 228, p. 645), is a fibro-cartilaginous ring about one-sixth of an inch wide, which is attached by fibrous tissue to the depression of the frontal bone at the inner angle of the orbit. A fibrous layer is prolonged from the margin of the pulley on to the tendon; and a synovial sheath lines the ring, to facilitate the movement of the tendon through it. To see the synovial sheath and the free motion of the tendon, this prolongation may be cut away. pulley of the muscle

use — For the use of the muscle, see the description of the inferior oblique (p. 650).

Dissection. **Dissection** (fig. 228). The superior rectus muscle is next to be divided about the middle and turned backwards when a branch of the third nerve to its under surface will be found. At the same time the *nasal nerve* and the *ophthalmic vessels* will come into view as they cross inwards above the optic nerve; these should be traced forwards to the inner angle, and backwards to the posterior part of the orbit.

Find lenticular ganglion, and roots. By taking away the fat between the optic nerve and the external rectus, at the back of the orbit, the student will find easily fine nerves (*ciliary*) with small arteries lying along the side of the optic nerve; and by tracing these ciliary nerves backwards, he will be guided to the small *lenticular ganglion* (the size of a pin's head). The dissector should find then two branches from the nasal and third nerves to the ganglion: the nasal branch is slender, and enters the ganglion behind; while that of the third nerve, short and thick, joins the lower part.

Clean eyeball. The eyeball is to be fully exposed by dissecting off its investing fascia (capsule of Tenon), which will be seen to send processes around the several muscles inserted into the sclerotic.

Separate nerves. Lastly, the student should separate from one another the nasal, third, and sixth nerves, as they pass between the heads of the external rectus muscle into the orbit.

Third nerve as it enters orbit; its upper branch, lower branch. The THIRD NERVE is placed highest in the wall of the cavernous sinus; but at the sphenoidal fissure it descends below the fourth, and the two superficial branches (frontal and lachrymal) of the ophthalmic nerve. It comes into the orbit between the heads of the outer rectus, having previously divided into parts.

The *upper division* (fig. 228, [8]) is the smaller, and ends in the under surface of the levator palpebræ and superior rectus muscles.

The *lower division* supplies the internal and inferior recti and the inferior oblique muscles, and will be dissected afterwards (p. 648).

Nasal nerve. The NASAL BRANCH OF THE OPHTHALMIC NERVE (fig. 228, [1]) enters the orbit between the heads of the external rectus, lying between the two parts of the third nerve, and is then directed obliquely inwards to reach the anterior of the two internal orbital canals.

General course to the face. Passing through this aperture with the anterior ethmoidal artery, the nerve appears in the cranium at the outer margin of the cribriform plate of the ethmoid bone. Finally, it enters the nasal cavity by an aperture at the front of the cribriform plate; and after passing behind the nasal bone, it issues between that bone and the cartilage, to end on the outer surface of the nose.

In the orbit. *In the orbit* the nasal crosses over the optic nerve, but beneath the superior rectus and levator palpebræ muscles, and lies afterwards below the superior oblique; in this part of its course it furnishes the following *branches:*—

Branches. Long root of lenticular ganglion. The *branch to the lenticular ganglion* ([5]) is about half an inch long and very slender, and arises as soon as the nerve comes into the orbit: this is the *long root* of the lenticular ganglion.

Long ciliary nerves. As the nasal crosses the optic nerve, it supplies two or more ciliary branches (fig. 228, 7) to the eyeball. These lie on the inner side of the optic nerve, and join the ciliary branches of the lenticular ganglion. Long ciliary branches.

The *infratrochlear branch* (2) arises as the nasal nerve is about to leave the cavity, and is directed forwards below the pulley of the Infra-trochlear branch.

FIG. 228.—SECOND VIEW OF THE ORBIT (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Superior oblique.
B. Levator palpebræ and upper rectus thrown back together.
C. External rectus.
D. Fore part of upper rectus.
F. Lachrymal gland.

Nerves:

1. Nasal.
2. Its infratrochlear branch.
3. Lenticular ganglion :—4, its short root; 5, its long root (too large).
6. Branch of third to inferior oblique muscle.
7. Ciliary branches of the nasal nerve.
8. Upper branch of the third.
9. Sixth nerve.
10. Third nerve, outside the orbit.

superior oblique muscle, to end in the upper eyelid, the conjunctiva, and the side of the nose. Before this branch leaves the orbit it receives an offset of communication from the supratrochlear nerve.

In the nose (fig. 239, 6, p. 675). While in the nasal cavity the nerve furnishes branches to the lining membrane of the septum and outer wall; and these will be subsequently referred to with the nerves of the nose (p. 677). Nasal nerve in the nose,

and in the face. *Termination of the nasal nerve.* After the nerve becomes cutaneous on the side of the nose, it descends beneath the compressor naris muscle, and ends in the integuments of the tip of the nose.

Lenticular ganglion: situation; connections. The OPHTHALMIC OR LENTICULAR GANGLION (fig. 228, 3) is a small reddish body, about the size of a pin's head, and in form nearly square. It is placed at the back of the orbit between the optic nerve and the external rectus, and commonly on the outer side of, and close to, the ophthalmic artery. By its posterior part the ganglion has branches of communication with other nerves (its roots); and from the anterior part proceed ciliary branches to the eyeball. The ganglion receives roots from sensory, motor, and sympathetic nerves.

Three roots: long, short, and sympathetic. The *branches of communication* are three in number. One, the *long root* (5), is the branch of the nasal nerve before noticed, which joins the superior angle. A second branch of considerable thickness, the *short root* (4), passes to the inferior angle from the branch of the third nerve that supplies the inferior oblique muscle. And the *sympathetic root* is derived from the cavernous plexus, either in union with the long root, or as a distinct branch to the posterior border of the ganglion.

Ciliary branches to eyeball. *Branches.* The *short ciliary nerves* (fig. 228), ten or twelve in number, are collected into two bundles, which leave the upper and lower angles at the front of the ganglion. In the upper bundle are four or five, and in the lower, six or seven nerves. In their course to the eyeball they lie along the outer and under parts of the optic nerve, and communicate with the long ciliary branches of the nasal nerve.

Ophthalmic artery, in the orbit. The OPHTHALMIC ARTERY (fig. 229), a branch of the internal carotid, enters the orbit through the optic foramen. At first the vessel is below and to the outer side of the optic nerve, but it then courses inwards over (or occasionally under) the nerve to the inner side of the orbit, and finally perforates the palpebral fascia above the internal tarsal ligament to end by dividing into frontal and nasal branches.

Branches: general distribution. The BRANCHES of the artery are numerous, though inconsiderable in size. They supply the structures within the orbit, and some leave that cavity to be distributed to the lining membrane of the cranium, to the interior and exterior of the nose, and to the adjoining part of the forehead.

Branch to retina. The *central artery of the retina* is a very small branch which pierces the optic nerve about half an inch behind the eyeball.

Ciliary arteries are posterior— The *ciliary branches* are divided into anterior and posterior, which enter the eyeball at the front and back :—

two named long ciliary, The *posterior ciliary* usually rise by two trunks—inner and outer, close to the optic foramen: they divide into a number of branches (from ten to twenty) which run to the eyeball around the optic nerve, and perforate the sclerotic coat at the posterior part Two of this set (one on each side of the optic nerve), are named long ciliary and

pierce the sclerotic farther out than the others, and lie along the middle of the eyeball.

The *anterior ciliary arteries* arise from muscular branches of the ophthalmic, and perforate the sclerotic coat near the cornea: in the eyeball they anastomose with the long ciliary. For the ending of these vessels, see the dissection of the eyeball, pp. 797 and 798. and anterior.

The *lachrymal artery* accompanies the nerve of the same name to the upper eyelid, where it ends by supplying that part, and joining in the arches in the eyelids. It supplies branches, like the nerve, to the lachrymal gland and the conjunctiva; and it communi- Lachrymal branch to gland and eyelids

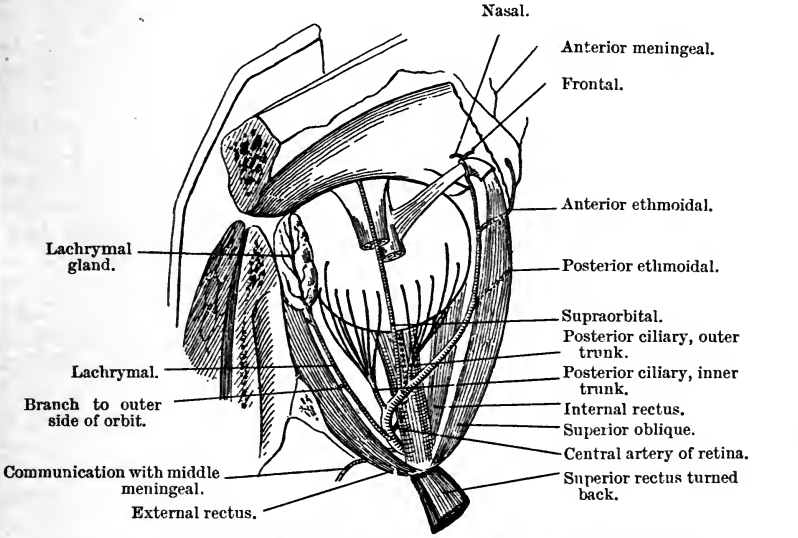


FIG. 229.—DIAGRAM OF THE OPHTHALMIC ARTERY AND ITS BRANCHES.

cates with the large middle meningeal artery by an offset through the sphenoidal fissure.

The lachrymal artery also sends twigs to the external rectus muscle, and a small branch with each of the divisions of the temporo-malar nerve; these join the temporal and transverse facial arteries. offsets through malar bone.

The *supraorbital branch* is small, and arises as the artery is crossing the optic nerve. It takes the course of the nerve of the same name through the notch in the margin of the orbit, and ends in branches on the forehead. Supraorbital branch.

The *muscular branches* are a *superior* to the upper and outer muscles, and an *inferior* to the lower and inner muscles, as well as small irregular offsets. Muscular.

The *ethmoidal branches* are two, anterior and posterior, and are directed through the canals in the inner wall of the orbit:— Ethmoidal branches,

The *posterior* is the smaller of the two, and often arises in common posterior

with the supraorbital artery. It ends in offsets to the mucous membrane of the upper part of the nose and the ethmoidal cells.

and anterior. The *anterior branch* (internal nasal) accompanies the nasal nerve to the cavity of the nose, and gives anterior meningeal offsets to the fore part of the falx cerebri and the dura mater of the anterior fossa of the skull.

Branches to eyelids. The *palpebral branches*, one for each eyelid, generally rise together opposite the pulley of the superior oblique muscle, and then separate from one another. The arches they form have been dissected with the eyelids (p. 569).

Frontal branch. The *frontal branch* turns round the margin of the orbit, and is distributed on the forehead (p. 503).

Nasal branch. The *nasal branch* (external) supplies the skin and muscles of the upper part of the nose, and anastomoses with the angular and lateral nasal branches of the facial artery.

Ophthalmic veins: The OPHTHALMIC VEINS are two in number, superior and inferior, and leave the orbit by the sphenoidal fissure, between the heads of

superior the external rectus, to end in the cavernous sinus. The *superior vein* is the larger and accompanies the artery: it begins in front by a wide communication with the angular vein, and on its way backwards it receives tributaries corresponding to most of the offsets of

and inferior. the artery. The *inferior vein* lies below the optic nerve, and is formed by the lower ciliary and muscular veins; it communicates through the spheno-maxillary fissure with the pterygoid plexus. The supraorbital, frontal and palpebral veins do not join the ophthalmic, but pass to the veins of the face.

Optic nerve The OPTIC NERVE in the orbit extends from the optic foramen to the back of the eyeball. As the nerve leaves the foramen it is surrounded by the recti muscles; and beyond that spot the ciliary

ends in retina. arteries and nerves entwine around it. It terminates in the retinal expansion of the eye.

Dissection. **Dissection** (fig. 230). Take away the ophthalmic vessels, and divide the optic nerve about its middle, together with the small ciliary vessels and nerves. Turn forwards the eyeball, and fasten it in that position with hooks. On removing some fat the three recti muscles—inner, inferior, and outer, will appear; and lying on the first two are the offsets of the lower division of the third nerve.

Lower division of third nerve The LOWER DIVISION OF THE THIRD NERVE (fig. 230) supplies three muscles in the orbit. As it enters this space, between the heads of the external rectus, it lies below the nasal, and rather above the sixth nerve. Almost immediately the nerve divides into three

supplies muscles, branches. One (5) passes to the internal, another (4) to the inferior rectus, both entering the muscles on their ocular surfaces, and the third (3), the longest and most external, is continued forwards to the inferior oblique muscle, which it pierces at its hinder border.

and joins ganglion, Soon after its origin the last branch communicates with the lenticular ganglion, forming the short root (fig. 228, 4) of that body; and it furnishes two or more filaments to the inferior rectus muscle.

The SIXTH NERVE (fig. 230, 2) lies below the other nerves, and above the ophthalmic veins, in the interval between the heads of the external rectus. In the orbit it first lies against, and then penetrates the inner surface of the external rectus muscle. Sixth nerve.

RECTI MUSCLES. The *internal* (fig. 230, D), *inferior* (C), and *external recti* (B) are placed with reference to the eyeball as their names express. They *arise* posteriorly from the circumference of the optic Straight muscles of eyeball: origin.

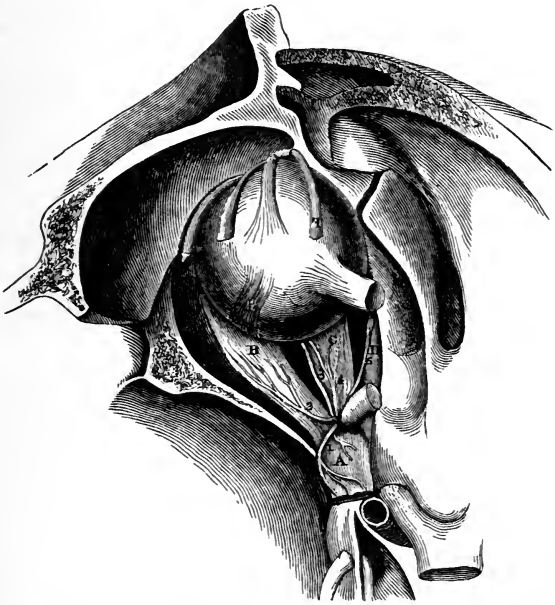


FIG. 230.—THIRD VIEW OF THE ORBIT (ILLUSTRATIONS OF DISSECTIONS).

Muscles:

A. Upper rectus and levator palpebræ thrown back together.
B. External rectus.
C. Inferior rectus.
D. Internal rectus.
F. Superior oblique cut, showing the insertion.
H. Insertion of inferior oblique.

Nerves:

1. Upper branch of the third.
2. Sixth nerve.
3. Branch of third to inferior oblique.
4. Branch of third to inferior rectus.
5. Branch of third to internal rectus.

foramen by a common attachment, which partly surrounds the optic nerve. The external rectus differs from the others in having two heads: the upper one arises on the outer margin of the optic foramen and joins the superior rectus in the common origin: the lower and larger head blends on the one side with the inferior rectus in the common origin, and on the other side is attached to a bony point on the lower border of the sphenoidal fissure near the inner end, while some of its muscular fibres are also connected with a tendinous band External rectus, two heads;

insertion. between the two heads. All the muscles are directed forwards, the lower ones also obliquely outwards, and have a tendinous *insertion* into the ball of the eye about a quarter of an inch from the cornea, and in front of the greatest transverse diameter of the ball.

Between heads of outer rectus. Between the heads of origin of the external rectus, the different nerves before mentioned are transmitted into the orbit, viz., the third, the nasal branch of the fifth, and the sixth, together with the ophthalmic veins.

Use of all; *Action.* The four recti muscles are attached to the eyeball at opposite sides in front of the greatest transverse diameter and are able to turn the pupil in opposite directions.

inner and outer, The *inner* and the *outer muscles* move the ball horizontally around a vertical axis, the former directing the pupil towards the nose and the latter towards the temple.

upper and lower, The *upper* and *lower recti* elevate and depress respectively the fore part of the ball around a transverse axis; but as the muscles are directed obliquely outwards, the upper muscle turns the pupil upwards and inwards, and the lower muscle turns it downwards and inwards.

and two adjacent. By the simultaneous action of two adjacent recti, the ball will be moved to a point intermediate to that to which it would be directed by either muscle singly.

Common tendinous origin of the recti. **Dissection.** By opening the optic foramen, the attachment of the recti muscles will be more fully laid bare, and they will be seen to arise from a tendinous ring which passes above, outside and inside the optic foramen, and bridges across the sphenoidal fissure from below the inner and outer sides of the foramen, the two fibrous bands meeting below at a small spicule of bone on the upper margin of the great wing of the sphenoid. To dissect out the inferior oblique muscle, let the eyeball be replaced in its natural position; then by separating from the facial aspect the lower eyelid from the margin of the orbit, and removing some fat, the muscle will appear beneath the eyeball arching from the inner to the outer side: if the external tarsal ligament be divided, it may be followed upwards to its insertion into the ball.

Dissect inferior oblique.

Lower oblique muscle: The INFERIOR OBLIQUE MUSCLE (fig. 230, H) is placed near the anterior margin of the orbit, and differs from the other muscles in being directed across, instead of parallel to the axis of the orbit.

origin; It *arises* from the superior maxillary bone immediately outside the

course; opening of the nasal duct. From this spot the muscle passes outwards between the inferior rectus and the bone and then between the

insertion; eyeball and the external rectus, to be *inserted* into the sclerotic coat between the outer and upper recti.

relations. The borders of the muscle look forwards and backwards, and the posterior receives its branch of the third nerve. The insertion of the tendon is near that of the superior oblique muscle, but rather closer to the optic nerve.

Action of oblique muscles: alone, *Action of the oblique muscles.* The superior oblique acting alone would draw the *back* of the eyeball upwards and inwards, and

therefore cause the *front* of the eye to be directed downwards and outwards. The inferior oblique would similarly turn *the front* of the eye upwards and outwards. In consequence of their transverse direction, these muscles would also tend to rotate the eyeball around its antero-posterior axis, the superior oblique depressing, and the inferior oblique elevating the inner end of the horizontal meridian of the eye, but movements of this nature take place only to a very limited extent during life.

The oblique muscles are believed to act mainly in controlling the tendency of the superior and inferior recti to rotate the eyeball and turn it inwards. Thus, to move the eye directly upwards, the superior rectus and the inferior oblique are used, while the inferior rectus and superior oblique co-operate in directing the eye downwards. and with superior and inferior recti.

Dissection. To expose the small tensor tarsi muscle, the remaining portion of the palpebral fascia is to be separated from the margin of the orbit; but the lids must be left attached at the inner side by means of the internal tarsal ligament. On clearing away a little areolar tissue in the neighbourhood of the inner commissure, after the lids have been placed across the nose, the pale fibres of the tensor tarsi will be seen. Seek tensor tarsi.

The TENSOR TARSI MUSCLE *arises* from the crest of the lachrymal bone, and slightly from the bone behind the crest. Its fibres are pale, and form a very small flat band, behind the internal tarsal ligament, which divides like that structure into a slip for each eyelid. In the lid the slip lies by the side of the lachrymal canal, and blends with the fibres of the orbicularis along the free margin of the tarsus. Tensor tarsi muscle: insertion;

Action. The tensor tarsi draws backwards the inner canthus of the eye and compresses the lachrymal sac, after it has been dilated by the orbicularis palpebrarum in the act of winking. use.

Dissection. A small nerve, the orbital branch of the superior maxillary trunk, lies along the lower part of the outer wall of the orbit, and is now to be brought into view by the *removal of the eyeball and its muscles.* This nerve is very soft and easily broken, and is covered, as it enters the orbit through the spheno-maxillary fissure, by pale fleshy fibres (orbitalis muscle). Two branches, temporal and malar, are to be traced forwards from it; and the junction of a filament of the lachrymal nerve with the former is to be sought close to the bone. The outer wall of the orbit may be cut away bit by bit, to follow the temporal branch to the surface of the head. Trace offset of superior maxillary nerve.

The TEMPORO-MALAR OR ORBITAL BRANCH of the superior maxillary nerve arises in the spheno-maxillary fossa, and divides at the back of the orbit into malar and temporal branches, which ramify on the face and the side of the head with companion vessels. Orbital branch of superior maxillary nerve:

The *malar branch* is directed forwards through the canal of the same name in the malar bone to supply the skin of the upper and outer part of the cheek, where it communicates with the malar branches of the facial nerve. its malar

and temporal offsets.

The *temporal branch* ascends in a groove in the bone on the outer wall of the orbit, and after being joined by a filament from the lachrymal nerve, passes into the temporal fossa through the temporal canal in the malar bone: it is then directed upwards between the temporal muscle and the skull, and perforates the temporal fascia near the orbit (p. 504).

Orbitalis muscle.

Orbitalis muscle. At the lower and outer angle of the orbit this thin layer of unstriped muscle is sometimes well seen. The fibres cross the spheno-maxillary fissure, being attached to the edges, and are pierced by the temporo-malar nerve.

Dissection in spheno-maxillary fossa;

Dissection. The contents of the orbit having now been removed, with the exception of the temporo-malar nerve, which is to be preserved if possible, the whole of the outer wall is to be cut away and the greater wing of the sphenoid chipped away so as to open up the spheno-maxillary fossa. Only an osseous ring should be left round the *superior maxillary division of the fifth nerve* where it issues from the skull through the foramen rotundum, and the exposure of the nerve as it crosses the fossa to pass on to the floor of the orbit will be completed by removing the fat. In the fossa the student seeks the following offsets,—the orbital branch entering the cavity of the orbit, branches to Meckel's ganglion which descend in the fossa, and the posterior dental branch along the back of the upper jaw.

Superior maxillary nerve.

in floor of orbit.

To follow onwards the nerve in the floor of the orbit, the contents of the cavity having been taken away, the bony canal in which it lies must be opened to its termination on the face. From the infraorbital canal the anterior and middle dental branches are to be traced downwards for some distance in the bone. The infra-orbital vessels are prepared with the nerve.

Infraorbital vessels.

Upper maxillary nerve

passes to face

through infraorbital canal.

The SUPERIOR MAXILLARY NERVE (fig. 231) commences at the Gasserian ganglion, and leaves the cranium by the foramen rotundum. The course of the nerve is almost straight to the face, across the spheno-maxillary fossa, and along the orbital plate of the upper maxilla through the infraorbital canal. Issuing from the canal by the infraorbital foramen, where it is concealed by the elevator of the upper lip, it ends in infraorbital or facial branches which radiate to the eyelid, nose, and upper lip.

After the nerve comes to lie on the floor of the orbit it is called the INFRAORBITAL NERVE.

Its branches are—to orbit;

BRANCHES.—*a.* The *orbital* or *temporo-malar branch* (4) has already been described.

to the nose and palate;

b. The *spheno-palatine branches* (3) descend from the nerve in the fossa, and supply the nose and the palate; they are connected with Meckel's ganglion, and will be dissected with it (SECTION XIII., p. 673).

to the hinder teeth and cheek;

c. The *posterior dental branch* (5) leaves the nerve near the upper jaw. It enters a canal in the maxilla, and supplies branches to the molar teeth and the lining membrane of the antrum; near the teeth it joins the middle dental nerve. Before entering the canal

it furnishes one or more offsets to the gum and the mucous membrane of the cheek.

After the nerve becomes the infraorbital it gives off—

d. and *e.* The *middle* and *anterior dental branches* which arise together or separately from the trunk in the floor of the orbit, and descend in special canals in the wall of the antrum to end in branches to the teeth, after forming loops of communication with one another, and with the posterior dental nerve. From the middle branch filaments are given to the bicuspid teeth ; and from the anterior to the canine and incisors, as well as a twig or two to the inferior meatus of the nose. to fore teeth ;

The terminal branches on the face, *palpebral*, *lateral nasal* and *labial*, have already been studied (p. 564). to lower eyelid ;

The INFRAORBITAL ARTERY is a branch of the internal maxillary in the spheno-maxillary fossa (p. 615). Taking the course of the Infraorbital artery

FIG. 231.—DIAGRAM OF THE SUPERIOR MAXILLARY NERVE.

2. Trunk of the nerve leaving the Gasserian ganglion.
3. Spheno-palatine branches.
4. Temporo-malar branch.
5. Posterior dental nerves.
6. Middle and anterior dental.
7. Facial branches.

nerve through the infraorbital canal, the vessel appears on the face beneath the elevator muscle of the upper lip ; and it ends in branches which are distributed, like those of the nerve, between the eye and mouth. On the face its branches anastomose with offsets of the facial and buccal arteries. In the canal in the maxilla the artery furnishes small twigs to the orbit, and a larger *anterior dental branch* which runs with the nerve of the same name to the incisor and canine teeth ; the dental branch also gives offsets to the antrum, and near the teeth it anastomoses with the posterior dental artery. ends in face : branches to orbit, and one to anterior teeth.

The *vein* accompanying the artery communicates in front with the facial vein, and terminates behind in the alveolar plexus. Infraorbital vein,

Direction. The examination of an eyeball may be omitted with advantage till after the dissection of the head and neck has been completed.

Section XI.

THE PHARYNX AND THE CAVITY OF THE MOUTH.

Direction.

Direction. In this section the students of the two sides must work together.

Detach pharynx from spine,

The pharynx can be examined only when it has been separated from the back of the head and the spinal column; and it will therefore be necessary to cut through the base of the skull in the manner indicated below, so as to have the anterior half, with the pharynx connected to it, detached from the posterior half.

detach head,

Dissection. The head is to be separated from the trunk by sawing through the vertebral column at the third dorsal vertebra unless the dissector of the thorax has already done this in his examination of the ligaments. The block then being removed from beneath the neck, the head is to be placed downwards, so that it may stand on the cut edge of the skull. Next the trachea and œsophagus, together with the vagus and sympathetic nerves, are to be cut near

Separate pharynx from vertebral column,

the first rib, and all are to be separated from the spine by drawing them forwards as high as the basilar process of the occipital bone, defining the base of the skull between the pharynx and the prevertebral muscles, but being careful not to injure either. Then incise the periosteum on the under surface of the exposed basilar part of

chisel through basi-occipital,

the occipital and cut through this part of the bone with a sharp chisel, directing the chisel somewhat backwards as it is driven into the skull cavity—a block being placed inside the skull against the base to give the necessary support. Next turn the head on its side

direction of a saw-cut,

and make a saw-cut on each side passing close behind the mastoid process and extending, internally, to the posterior limit of the jugular

complete division with chisel.

foramen. The division of the skull will then be completed by chiselling, from within the cranial cavity, backwards through the base between the outer end of the chisel-cut through the basi-occipital and the inner end of the saw-cut behind the jugular foramen, taking care that the chisel passes in this operation on the *inner* side of the jugular foramen and the inferior petrosal sinus. The base of the skull is now divided into two parts (one having the pharynx attached to it, the other articulating with the spine), which can be readily separated with a scalpel.

Preserve piece of spine.

The spinal column with the piece of the occipital bone connected with it should be set aside, and kept for after examination by the workers on the two sides together.

Fasten pharynx,

Dissection *of the pharynx* (fig. 232, p. 656). Let the student take the anterior part of the divided skull, and, after moderately filling the pharynx with tow, fasten it with hooks on a block, so that the œsophagus may be pendent and towards him.

then clean muscles, viz.

He will then proceed to remove the fascia from the constrictor muscles, in the direction of their fibres, and complete the separation

of the different structures lying against the pharyngeal wall from one another and make out their relations from the fresh point of view. The margins of the inferior and middle constrictor muscles are to be defined. Beneath the lower one, near the larynx, will be found the recurrent nerve with companion vessels; between the inferior and middle are the superior laryngeal nerve and vessels; and the stylo-pharyngeus muscle disappears beneath the upper border of the middle constrictor.

lower and middle constrictor,

To see the attachment of the superior constrictor to the lower jaw and the pterygo-maxillary ligament, it will be necessary to cut through the internal pterygoid muscle. Above the upper fibres of this constrictor, and near the base of the skull, are two small muscles of the palate (F and H) entering the pharynx: one, tensor palati, lies close inside the internal pterygoid muscle; and the other, levator palati, is deeper and larger.

upper constrictor.

The PHARYNX is a portion of the alimentary canal which gives passage to both food and air. It is placed behind the nose, mouth and larynx, and extends from the base of the skull to the lower border of the cricoid cartilage of the larynx, where it ends in the œsophagus on a level with the lower part of the sixth cervical vertebra. In form it is somewhat conical, with the dilated part upwards; and its length averages about four and a half inches, but varies according to the position of the head and the degree of elevation of the larynx.

Pharynx: extent; form; length;

The tube of the pharynx is incomplete in front, where it communicates with the cavities above mentioned, but is closed above, behind, and at the sides. Below, it opens into the gullet. On each side of it are placed the trunks of the carotid arteries, with the internal jugular vein, and the accompanying cranial and sympathetic nerves. Behind it is the spinal column, covered by muscles, viz., longi colli and recti capitis antici.

is an incomplete bag; relations;

In front, the pharynx is united to the larynx, the hyoid bone, the tongue, and the bony framework of the nasal fossæ, which form the boundaries of its cavity in this direction. Behind and at the sides, it has a special muscular wall, and is only united by very loose connective tissues to surrounding parts. At the upper end the bag is completed by a fibrous aponeurosis which fixes it to the base of the skull; and the whole is lined by mucous membrane.

attachments, and construction.

The *aponeurosis* of attachment is seen at the upper part of the pharynx, where the muscular fibres are absent, to connect the tube to the base of the skull, and to complete the posterior boundary. Superiorly it is fixed to the basilar process of the occipital, and the petrous part of the temporal bone; but inferiorly it becomes thin, and is lost in the layer of connective tissue between the muscular and mucous strata. On this membrane some of the fibres of the superior constrictor muscle terminate.

Aponeurosis of pharynx.

The MUSCLES of the pharyngeal wall are arranged in two layers— an outer comprising the three constrictors, the fibres of which run more or less transversely to the direction of the tube, and an inner

Muscles in two layers.

Pharyngeal fascia.

of longitudinal fibres derived from the stylo-pharyngeus and palato-pharyngeus. Externally the constrictor muscles are covered by a

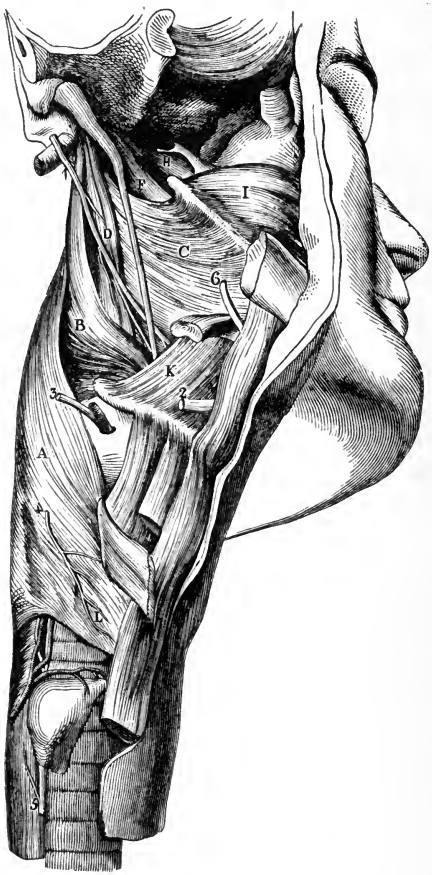


FIG. 232.—EXTERNAL VIEW OF THE PHARYNX (ILLUSTRATIONS OF DISSECTIONS).

Muscles :

A. Inferior constrictor
B. Middle constrictor.
C. Upper constrictor.
D. Stylo-pharyngeus.
F. Levator palati.
H. Tensor palati.
I. Buccinator.
K. Hyo-glossus.

Nerves :

1. Glosso-pharyngeal.
2. Hypoglossal.
3. Superior laryngeal.
4. External laryngeal.
5. Inferior, or recurrent, laryngeal.
6. Lingual.

fascia, which is continued forwards above, beneath the internal pterygoid muscle, to the surface of the buccinator.

The INFERIOR CONSTRICTOR (fig. 232, A), the most superficial, *arises* from the side of the cricoid cartilage, and from the inferior cornu, oblique line, and upper border of the thyroid cartilage. The origin is small when compared with the insertion, for the fibres radiate as they pass backwards, to be *inserted* along the middle line, where the muscles of opposite sides join. Lower constrictor arises from larynx and ends in the middle line:

The outer surface of the muscle is in contact with the sheath of the carotid vessels, and with the muscles covering the spinal column. The lower border is nearly horizontal, and beneath it the inferior laryngeal nerve and vessels (5) pass; while the upper border ascends very obliquely and overlaps the middle constrictor. A few of the lowest fibres of the muscle turn downwards, and are continued into the longitudinal fibres of the œsophagus. parts in contact with it.

The MIDDLE CONSTRICTOR (fig. 232, B) has a similar shape to the preceding, that is to say, it is narrowed in front and expanded behind. Its fibres *arise* from the great and small cornua of the hyoid bone on a deeper plane than the hyo-glossus and from the stylo-hyoid ligament. From this origin the fibres radiate, and are blended along the middle line with those of the opposite muscle. Middle constrictor arises from hyoid bone:

The posterior surface of this muscle is to a great extent concealed by the inferior constrictor. Laterally, it touches the carotid sheath; and its origin is beneath the hyo-glossus muscle, the lingual artery passing between the two. Its upper border is separated from the superior constrictor by the stylo-pharyngeus; and in the interval between the origins of the middle and inferior constrictors are the superior laryngeal nerve and vessels. relations.

The SUPERIOR CONSTRICTOR is thinner than the others, and of a quadrilateral form. It has a broad *origin* from the following parts in succession, commencing above,—the lower end of the internal pterygoid plate and the hamular process, the pterygo-maxillary ligament, the hinder part of the mylo-hyoid ridge of the lower jaw, the mucous membrane of the mouth, and the side of the tongue. Upper constrictor arises from pterygoid process, jaw and tongue:

The fibres pass backwards, and are *inserted* by joining those of the fellow muscle along the middle line, where a tendinous raphé is formed between the two for the upper half of their depth. Some of the highest fibres reach the tubercle on the under surface of the basi-occipital and others end on the aponeurosis of the pharynx. inserted partly into a raphé;

The parts in contact with this muscle externally are the deep vessels and nerves of the neck at the side, the middle constrictor and prevertebral muscles behind: internally are the aponeurosis of the pharynx and the palato-pharyngeus muscle. The upper border forms an arch with the concavity upwards extending from the pterygoid plate to the basilar process; and the space between it and the base of the skull is occupied by the aponeurosis of the pharynx, which projects outwards above the muscle, and by the levator palati, Eustachian tube and inferior palatine artery. The attachment to the pterygo-maxillary ligament corresponds with the origin of the buccinator muscle (1) between the two maxillary bones. relations: interval between muscle and skull.

Action of constrictors. The muscles of both sides contracting at the Use of constrictors

same time will diminish the size of the pharynx ; and as the anterior attachments of the lower muscles are nearer together than those of the upper, the tube will be contracted more behind the larynx than near the head.

in swallowing ; In swallowing, the object is first seized by the lower part of the upper constrictor, and then forced on to the œsophagus by the successive action of the middle and inferior constrictors. Since the back of the pharynx is closely applied to the prevertebral muscles, from which it cannot be separated in the natural condition of the parts, the effect of the contraction of these muscles is to draw the tongue, hyoid bone and larynx backwards, as well as somewhat upwards owing to the oblique direction of the greater number of the fibres of the middle and lower constrictors ; and the cavity, when empty, is compressed from before backwards.

of upper constrictor. The upper part of the superior constrictor narrows the space above the mouth, and assists in bringing together the posterior pillars of the soft palate. (See the action of the palato-pharyngeus, p. 664.)

Pterygo-maxillary ligament. The *pterygo-maxillary ligament* is a thin fibrous band which passes from the tip of the hamular process to the hinder end of the mylo-hyoid ridge of the lower jaw, and gives origin in front to the middle fibres of the buccinator and behind to the superior constrictor. It is often partly concealed externally by the meeting of the fleshy fibres of the two muscles.

Dissection to show **Dissection** (fig. 233). By dividing the middle and inferior constrictors midway between their origin and insertion, and reflecting the parts forwards and backwards, the longitudinal fibres of the pharyngeal wall will be exposed.

longitudinal muscles. The LONGITUDINAL OR ELEVATOR MUSCLES of the pharynx are the stylo-pharyngeus and palato-pharyngeus. The *stylo-pharyngeus* has already been described (p. 626), but it may now be followed to its insertion. The *palato-pharyngeus* is only partially seen, and will be described with the muscles of the soft palate. Its fibres appear behind those of the stylo-pharyngeus, and descend to the lower part of the pharynx, reaching backwards to the middle line.

Dissection. **Dissection** (fig. 233). Open the pharynx by an incision along the middle, and, after removing the tow from the interior, keep it open with hooks : a better view of the cavity will be obtained by partly dividing the occipital attachment on each side.

Interior of pharynx. The INTERIOR OF THE PHARYNX is wider from side to side than from before backwards, and its greatest width is opposite the hyoid bone ; from that spot it diminishes both upwards and downwards, but much more rapidly in the latter direction. In it the following objects are to be noticed.

Objects to be noted. At the top are situate the posterior apertures (G) of the nasal fossæ, which are separated by the septum nasi. Below them hangs the soft palate, partly closing the opening into the mouth ; and from its free margin a prominent fold of the mucous membrane, the posterior pillar of the fauces (L), is continued downwards and backwards on each side of the pharynx. Immediately behind each nasal

aperture is the trumpet-shaped end of the Eustachian tube; and from the anterior extremity of the prominence formed by the tube, a ridge descends to join the posterior pillar of the fauces. Behind

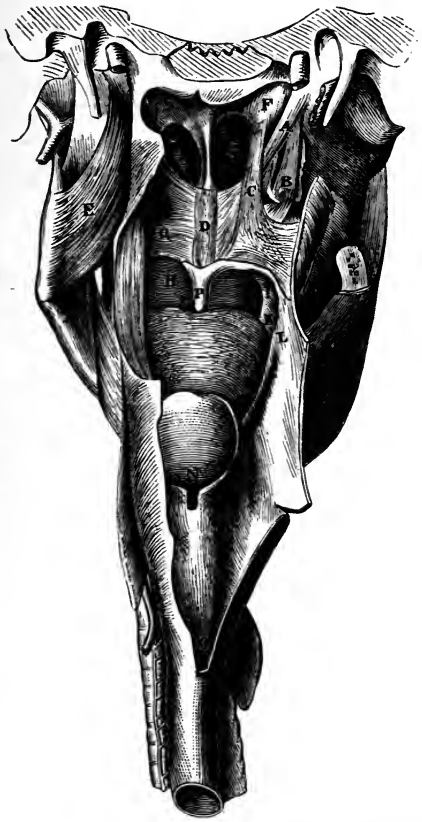


FIG. 233.—INTERIOR VIEW OF THE PHARYNX (ILLUSTRATIONS OF DISSECTIONS.)

Muscles of the Palate, and named parts:

A. Levator palati.
B. Tensor palati.
C. Salpingo-pharyngeus.
D. Azygos uvulæ.
E. Internal pterygoid.
F. End of the Eustachian tube.
G. Posterior naris.
H. Mouth cavity.
I. Anterior pillar of fauces.
K. Position of tonsil.
L. Posterior pillar of fauces.
N. Opening of larynx.
O. Opening of œsophagus.
P. Uvula.
Q. Superficial part of palato-pharyngeus.

the opening of the Eustachian tube the mucous membrane is prolonged into a deep hollow, the *lateral recess of the pharynx*, which corresponds to the projection of the aponeurosis of the pharynx seen externally.

On raising the soft palate, the opening into the mouth—isthmus faucium (H) is exposed, bounded laterally by a mucous fold which descends to the tongue and is named the anterior pillar of the fauces; while between the anterior and posterior pillars on each side is a hollow containing the tonsil (K).

Next in order, below the mouth, comes the aperture of the larynx (N) with the epiglottis projecting above it. Lowest of all is the opening (O) from the pharynx into the œsophagus.

Seven apertures, viz.—

The *apertures* into the pharynx are seven in number, and have the following position and boundaries:—

Posterior nares.

The *posterior openings of the nasal fossæ* (choanæ; G) are oval in form, and measure about an inch from above downwards, but only half an inch across. Each is constructed in the dried skull by the sphenoid, with the vomer and palate bones above, by the palate below, by the vomer internally, and by the internal pterygoid plate on the outer side.

Eustachian tube

The EUSTACHIAN TUBE (F) is a canal, partly osseous, partly cartilaginous, by which the tympanic cavity of the ear communicates with the external air.

cartilaginous part;

If the mucous membrane be removed from the tube on the right side, the cartilaginous part is seen to be nearly an inch long. It is fixed above to a groove between the petrous part of the temporal and the sphenoid bones, and ends in front by a wide opening on the inner side of the internal pterygoid plate, on a level with the posterior extremity of the inferior spongy bone of the nose (fig. 237, p. 670). Its opening in the pharynx is oval in form, and the inner margin projects forwards, giving rise to a trumpet-shaped mouth.

pharyngeal opening;

construction.

This part of the tube is constructed of a triangular piece of yellow fibro-cartilage, which is bent downwards on each side so as to enclose a narrow space. The inner portion is larger than the outer, and increases in breadth from behind forwards. On its outer side the tube is completed by fibrous tissue. The cartilage is covered on its inner side by mucous membrane, and through the tube the mucous lining of the cavity of the tympanum is continuous with that of the pharynx.

Fauces.

The space included between the root of the tongue and the soft palate is called the *fauces*. It is wider below than above; and on each side lies the tonsil.

Isthmus of the fauces.

The ISTHMUS FAUCIUM (H) is the narrowed aperture of communication between the mouth and the pharynx. It is bounded above by the soft palate, below by the tongue, and on the sides by the anterior pillars of the soft palate. Its size varies with the movements of these parts, and it can be closed by the meeting of the soft palate and the tongue.

Upper opening of larynx.

The APERTURE OF THE LARYNX (N) is wide in front, where it is bounded by the epiglottis, and pointed behind between the arytenoid cartilages. The sides are sloped from before backwards, and are formed by folds (aryteno-epiglottidean) of the mucous membrane extending between the arytenoid cartilages and the epiglottis. Behind it is limited by the cornicula laryngis, and by the arytenoid muscle covered by mucous membrane. During respiration this

aperture is unobstructed, but in the act of deglutition it is closed by the approximation of the lateral folds and the lower part of the epiglottis.

Beginning of œsophagus.

The OPENING INTO THE ŒSOPHAGUS (o) is the narrowest part of the pharynx, and is opposite the cricoid cartilage and the sixth cervical vertebra. At this spot the mucous membrane in the œsophagus becomes paler than in the pharynx; and the point at which the pharynx ends is marked externally by a slight contraction, and by a change in the direction of the muscular fibres.

Subdivision of cavity of pharynx into nasal,

The CAVITY OF THE PHARYNX is divided into *three* parts, which differ in their function with regard to the transmission of the food and air. The upper or *nasal portion* is limited below by the soft palate and its posterior pillars; it gives passage only to air, and is always open.

oral.

The middle or *oral portion* extends downwards to the aperture of the larynx, and is traversed by both food and air; it is open when breathing through the mouth, but closed when breathing solely through the nose, the aperture of the larynx then corresponding to the interval between the posterior pillars.

and laryngeal portions.

The third part being behind the larynx is termed *laryngeal*, and only transmits food; its walls are naturally in contact, except during the act of deglutition.

Soft palate at back of mouth:

The SOFT PALATE (velum pendulum palati; Q) is a moveable structure between the mouth and the pharynx, which can either close the opening of the mouth, or cut off the communication with the nose, according as it is depressed or elevated.

surfaces;

In the usual position of the soft palate (the state of relaxation) its anterior surface is concave, and is continuous with the roof of the mouth; while the opposite surface is convex and turned to the pharynx.

borders;

The upper border is fixed to the posterior margin of the hard palate; and on each side it joins the pharynx.

from it hangs uvula.

The lower border is free, and is produced in the centre into a conical pendulous part —the *uvula* (P). Along its middle is a slight ridge, indicative of the original separation into two halves.

Arches or pillars:

Descending from the soft palate on each side of the fauces are the two folds of mucous membrane before referred to, containing muscular fibres, and named the *arches* or *pillars of the soft palate* or *fauces*.

anterior;

The *anterior pillar* (I) springs from the anterior surface of the soft palate near the base of the uvula, and reaches to the side of the tongue rather behind the middle;

posterior.

and the *posterior* (L), longer than the other, is continued from the lower border of the velum to the side of the pharynx. As they diverge from their origin to their termination, they limit a triangular space in which the tonsil lies.

Constituents of velum.

The soft palate consists of an aponeurosis, with muscles, vessels, nerves, and mucous glands; and the whole is enveloped by the mucous membrane.

Dissect

Dissection. Some of the muscles of the palate are readily displayed, but others require care in their dissection.

levator and tensor on right half;

The two principal muscles of the soft palate—the elevator and

tensor, are very plain. These have already been partly dissected; but to follow them to their termination, let the upper attachment of the pharynx *on the right side*, and the part of the superior constrictor which arises from the internal pterygoid plate be cut through. The levator will be fully laid bare by the removal of the mucous membrane and a few muscular fibres covering its lower end. The tendon of the tensor palati should be followed round the hamular process of the internal pterygoid plate; and its situation in the palate beneath the levator should be made evident. The position of the Eustachian tube with respect to those muscles should also be ascertained.

on left, palato-pharyngeus,

On the left side, the mucous membrane is to be raised with great care from the posterior surface of the soft palate, to obtain a view of the superficial muscular fibres. Immediately beneath the mucous covering are some fine transverse fibres of the palato-pharyngeus muscle; and beneath them, close to the middle line, are the longitudinal fibres of the azygos uvulæ. A slender muscular bundle contained in the ridge of mucous membrane descending from the extremity of the Eustachian tube is to be exposed and traced to its junction with the palato-pharyngeus. On the right side, a deeper set of fibres of the palato-pharyngeus is to be followed beneath the levator and azygos muscles.

azygos uvulæ,

and palato-glossus.

The mucous membrane should next be removed from the muscular fibres contained in the arches of the palate, and the muscle fibres should be followed upwards and downwards. In order to see those in the anterior fold, it will be necessary to take the membrane away from the anterior surface of the palate. If the part is not tolerably fresh, some of the paler fibres may not be visible.

Aponeurosis of palate.

Aponeurosis of the soft palate. Giving strength to the velum is a thin but firm aponeurosis, which is attached to the hard palate. This membrane becomes thinner as it descends in the velum; and it is joined by the tendon of the tensor palati muscle.

Nine muscles in it.

The MUSCLES OF THE SOFT PALATE are, on each side, an elevator and tensor, which descend from the skull, with the palato-glossus and palato-pharyngeus, which act as depressors, and a small median azygos muscle.

Elevator muscle arises outside pharynx,

The LEVATOR PALATI (fig. 233, A; 234, [3]) is a thick roundish muscle which is partly situate outside the pharynx. It *arises* from the under surface of the petrous portion of the temporal bone close in front of the carotid foramen, and from the lower border of the adjacent cartilaginous part of the Eustachian tube. Entering the pharynx above the superior constrictor, the fibres of the muscle spread out in the soft palate, where they join along the middle line with those of the muscle of the opposite side.

and is lost in velum;

relations.

The belly of the muscle rests against the lower border of the Eustachian tube; and the expanded part is embraced by two layers of fibres of the palato-pharyngeus (4).

Action. It raises the soft palate from the tongue, so as to enlarge the fauces; and by bringing the hinder part of the velum into

contact with the posterior wall of the pharynx, it can shut off the upper part of that cavity, as in vocalisation, when the air is prevented from passing through the nose.

The TENSOR OR CIRCUMFLEXUS PALATI (fig. 233, B ; 234 [2]) is a thin flattened muscle, lying immediately behind the internal pterygoid plate. About an inch wide at its *origin*, it is attached to the scaphoid fossa at the root of the internal pterygoid plate, to the outer side of the Eustachian tube, and to the spinous process of the sphenoid. The fleshy fibres end below in a tendon, which turns round the hamular process, and is *inserted* into a ridge close to the posterior border of the hard palate, and blends inferiorly with the aponeurosis of the velum.

Tensor muscle

arises outside pharynx;

inserted into aponeurosis of soft palate;

The fleshy part of the tensor palati is placed between the internal

relations;

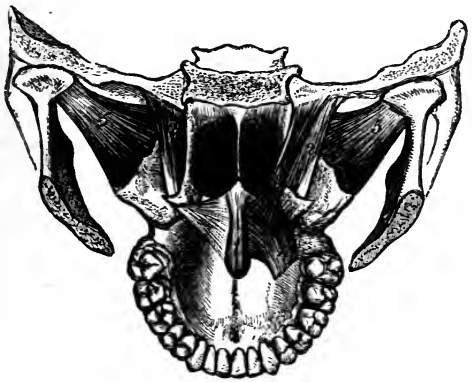


FIG. 234.

1. Azygos uvulæ.
2. Tensor palati.
3. Levator palati.
4. Palato-pharyngeus — upper end.
5. External pterygoid.

pterygoid muscle externally and the Eustachian tube and levator palati internally. The tendon enters the pharynx between the attachments of the buccinator muscle, and is thrown into folds as it winds round the hamular process, a bursa being placed between the two. In the soft palate it lies between the palato-pharyngeus and palato-glossus.

Action. Acting from the skull the muscle will fix and make tense the soft palate ; but its movements will be very limited, seeing that the tendon is inserted partly into the palate bone.

use on palate,

The soft palate being fixed by its depressor muscles, the tensor, taking its fixed point below, opens the Eustachian tube in swallowing.

on tube.

The PALATO-GLOSSUS MUSCLE (constrictor isthmi faucium) is a small, pale band of fibres, which is contained in the anterior pillar (fig. 233, 1) of the soft palate. It is connected below with the side of

Palato-glossus: attachments;

the tongue; from this spot the fibres ascend in front of the tonsil to the anterior aspect of the soft palate, where they form a thin muscular stratum, and join those of the fellow muscle along the middle line.

relations; At its origin the muscle is blended with the glossal muscles, and at its insertion it is placed beneath the tensor palati.

use. *Action.* The palato-glossus closes the isthmus of the fauces, bringing the soft palate into contact with the tongue, and approximating the anterior pillars, thus shutting off the mouth from the pharynx.

Palato-pharyngeus The PALATO-PHARYNGEUS (fig. 233, Q; 234, [4]) is much larger than the preceding muscle, and gives rise to the eminence of the posterior pillar of the soft palate. It begins in the soft palate in two layers, which enclose between them the levator palati and azygos uvulæ muscles. The superficial part, very thin, and situate immediately beneath the mucous membrane, meets in the middle line the corresponding part of the opposite muscle; it is also joined by a slender fasciculus, which descends from the anterior extremity of the cartilage of the Eustachian tube (*salpingo-pharyngeus*, Santorini; fig. 233, c). The deep or anterior layer is much stronger, and lies between the levator and tensor palati muscles; its upper fibres spring from the hinder margin of the hard palate and the aponeurosis of the velum, while the lower ones join those of the opposite side. The two layers meet at the outer part of the soft palate, and the muscle descends behind the tonsil on the side wall of the pharynx. Spreading out below, the anterior fibres are inserted into the hinder border of the thyroid cartilage, but the greater number end in the submucous tissue of the pharynx beneath the inferior constrictor, the hinder ones meeting the fellow muscle in the middle line.

forms two layers in velum;

posterior layer is joined by salpingo-pharyngeus;

anterior layer is larger:

inserted into thyroid cartilage and wall of pharynx;

use; *Action.* The palato-pharyngeus depresses and tightens the soft palate, raises the larynx and lower part of the pharynx, and at the same time brings together the posterior pillars of the fauces, thus acting as a sphincter by which the nasal portion is separated from the oral portion of the pharynx. In swallowing, the hinder pillars of the soft palate, being approximated by the action of this muscle, form, together with the uvula, an inclined plane, beneath which the food is directed downwards. The contraction of the salpingo-pharyngeus at the same time assists in opening the Eustachian tube, by drawing inwards and backwards the cartilage bounding its orifice.

in swallowing;

of salpingo-pharyngeus.

Azygos muscle is in two slips; The AZYGOS UVULÆ (fig. 233, D; 234,[1]) is situated along the middle line of the velum near the posterior part. The muscle consists of two narrow slips of pale fibres, which *arise* from the spine at the posterior border of the hard palate, or from the contiguous aponeurosis, and end below in the base of the uvula. Behind this muscle, separating it from the mucous membrane, is the thin stratum of the palato-pharyngeus.

use. *Action.* Its fibres shorten the mid-part of the soft palate, and elevate the uvula, directing that process backwards.

The TONSIL is an oval body, of variable size, placed above the root of the tongue, in a recess between the anterior and posterior pillars of the soft palate. Externally it is covered by the superior constrictor muscle, and is a little above the angle of the lower jaw. Tonsil is between pillars of fauces:

The surface of the tonsil is marked by apertures, which lead into crypts, or recesses, lined by mucous membrane. Its substance consists mainly of lymphoid tissue, partly diffused, and partly collected into follicles set round the walls of these recesses. A similar collection of lymphoid tissue stretches across the posterior wall of the pharynx, between the openings of the Eustachian tube, and is known as the *pharyngeal tonsil*. structure. Pharyngeal tonsil.

The *arteries* of the tonsil are numerous, and are derived from the facial, lingual, ascending pharyngeal and internal maxillary branches of the external carotid. Its *veins* have a plexiform arrangement on the outer side. *Nerves* are furnished to it from the fifth and glosso-pharyngeal. Its *lymphatics* join the deep cervical glands. Vessels, and nerves.

The MUCOUS MEMBRANE OF THE PHARYNX is continuous in front with the lining of the nose, mouth and larynx. A fold encloses the muscles and glands of the soft palate, from which the membrane descends on each side over the tonsil to the tongue. It is also prolonged by the Eustachian tube to the tympanum; and below, it is continued into the œsophagus. It is provided with numerous mucous glands in the upper part of the pharynx, and on both surfaces, but especially the upper, of the soft palate. Another collection of glands (*arytenoid*) is enclosed in the fold of mucous membrane bounding the opening of the larynx on each side. The epithelium is columnar and ciliated above the soft palate, but scaly and stratified below that part. Mucous membrane of pharynx: glands; epithelium.

The ŒSOPHAGUS. This tube is much smaller than the pharynx, and the walls are flaccid. It consists of two layers of muscular fibres, with a lining of mucous membrane. The *external layer* is formed of longitudinal fibres, which begin opposite the cricoid cartilage by three bundles, an anterior and two lateral; the former is attached to the ridge at the back of the cartilage, and the others join the inferior constrictor. The *internal layer* is formed of circular fibres, which are continuous with those of the inferior constrictor. The structure of the œsophagus is described more fully in the dissection of the thorax. Beginning of œsophagus. Two layers of muscular fibres; outer longitudinal, and inner circular.

The CAVITY OF THE MOUTH. The cavity of the mouth extends from the lips in front to the anterior pillars of the fauces behind. Its boundaries are partly osseous and partly muscular, and its size depends upon the position of the lower jaw-bone. When the lower jaw is moderately removed from the upper, the mouth is an oval cavity with the following boundaries. The *roof*, concave, is constituted by the hard and soft palate, and is limited in front and on the sides by the arch of the teeth. In the *floor* is the tongue, surrounded by the arch of the lower teeth; and beneath that body is the sublingual gland on each side. Each *lateral boundary* consists of the cheek and the ramus of the lower jaw; and in it, near the second Mouth. form, and boundaries.

molar tooth in the upper jaw, is the opening of the parotid duct. The anterior opening of the mouth is bounded by the lips; and the posterior is the isthmus faucium, leading into the pharynx. The

Vestibule. space between the lips and the teeth is distinguished from the rest of the cavity as the *vestibule of the mouth.*

Lining of the mouth The *mucous membrane* is less sensitive on the hard than on the soft boundaries of the mouth; it lines the interior of the cavity, and is reflected over the tongue. In front it is continuous with the skin, and behind with the lining of the pharynx. The epithelium covering the membrane is scaly and stratified.

differs in parts: on roof, Between each lip and the front of the corresponding jaw the membrane forms a small fold—frænulum. Over the bony part of the roof it blends with the dense tissue enclosing the vessels and nerves; on the soft palate it is smooth, and thinner. Along the middle of the roof is a slightly raised raphé, which ends in front opposite the anterior palatine fossa in a small papilla; and on each side of this, at the fore part of the hard palate, there are two or

floor, three irregular transverse ridges. In the floor of the mouth the membrane forms the frænum linguæ beneath the tip of the tongue, and on each side of the frænum it is raised into a ridge by the sublingual gland, at the fore part of which is a small papilla, perforated

cheek, and lips. by the opening of Wharton's duct. On the interior of the cheek and lips the mucous lining is smooth, and is separated from the muscles by small buccal and labial glands.

Papillæ. Over the whole cavity, but especially on the lips and tongue, are papillæ.

Cheek; extent, and structure. The CHEEK extends from the commissure of the lips to the ramus of the lower jaw, and is attached above and below to the alveolar process of the jaw on the outer aspect. The chief constituent of the cheek is the fleshy buccinator muscle: on the inner surface of this is the mucous membrane; and on the outer the integuments, with some muscles, vessels, and nerves. The parotid duct perforates the cheek obliquely opposite the second molar tooth of the upper jaw.

Lips, formed by orbicularis, The LIPS surround the opening of the mouth; they are formed mainly by the orbicularis oris muscle covered externally by integument and internally by mucous membrane. The lower lip is the larger and more moveable of the two. Between the muscular structure and the mucous covering lie the *labial glands;* and in the substance of each lip, internal to the muscular structure, and separated

contain arteries. from the free edge by the marginal bundle of the orbicularis, is placed the arch of the coronary arteries.

Teeth; number and arrangement in jaw. TEETH. In the adult there are sixteen teeth in each jaw, which are set in the alveolar borders in the form of an arch, and are surrounded by the gums. Each dental arch has its convexity turned forwards; and, commonly, the arch in the maxilla overhangs that in the mandible when the jaws are in contact. The teeth are similar in the half of each jaw, and have received the following names:—the most anterior two are incisors, and the one next behind is the canine tooth; two, still farther back, are the two bicuspids; and the last

three are molar teeth. For details as to the form and structure of the teeth reference must be made to a work on systematic or general anatomy.

Section XII.

DISSECTION OF THE NOSE.

Directions.

The skull will now be divided from before backwards into two halves for the examination of the nasal cavity and of various remaining parts of the anatomy of the skull. The tongue and larynx will be separated, as directed, and put aside for examination by the workers on the two sides together; after which they will similarly examine the prevertebral region and the ligaments. In this Section also, and in the next, the students work together. While examining the boundaries of the nose, the student should be provided with a similar section of a macerated skull. It is also desirable, in order to fully comprehend the form of the cavity, that he should have the opportunity of inspecting a coronal section of the nose in the recent state.

Dissection.

Dissection. Before sawing the bone, the loose part of the lower jaw should be taken away, and the tongue, hyoid bone, and larynx, all united, are to be detached from the opposite half of the lower jaw, and laid aside till the dissectors are ready to use them.

Cut through the bones with saw.

On the right side of the middle line saw carefully through the frontal and nasal bones, the cribriform plate of the ethmoid, and the body of the sphenoid bone, without letting the saw descend more than can be helped into the nasal cavity.

Cut soft parts, and saw bone in roof of mouth.

Next the roof of the mouth is to be turned upwards, and the soft parts are to be divided on the right side opposite the cut in the roof of the nose. Then by sawing through the hard palate and the alveolar process of the upper jaw along the same line, the piece of the skull will be separated into two parts, right and left; the right half will serve for the examination of the meatuses, and the left will show the septum nasi, after the mucous membrane has been removed.

Situation of nose.

The CAVITY OF THE NOSE is placed in the centre of the bones of the face, being situate above the mouth, below the cranium, and between the orbits. The space is divided into two nasal fossæ by a vertical partition, the septum.

Division into two.

Form and dimensions.

Each fossa is elongated from before backwards, and compressed from side to side. Its length is greater below than above, and measures near the floor about three inches. Its height in the middle of the cavity is about one inch and three-quarters, becoming less in front and behind. The upper part of the fossa is narrow (fig. 235, p. 668), not exceeding one-eighth of an inch in breadth, and has been named the *olfactory cleft*, which extends down as far as the lower border of

the middle turbinate bone; below this the outer wall recedes, forming the *respiratory passage*, which has a width near the floor of about three-fifths of an inch. In front, each fossa opens on to the face, and behind into the pharynx, by orifices called *nares*. Other apertures in the roof and outer wall lead into *air-sinuses* in the surrounding bones, viz., frontal, ethmoid, sphenoid, and superior maxillary. Each fossa presents for examination a roof and floor, an inner and outer wall, and an anterior and posterior opening.

Openings.

Roof.

The ROOF is strongly arched from before backwards, and is formed by the cribriform plate of the ethmoid bone in the centre; by the frontal and nasal bones, and the lateral cartilages in front; and by the body of the sphenoid, and the sphenoidal spongy bone, and the

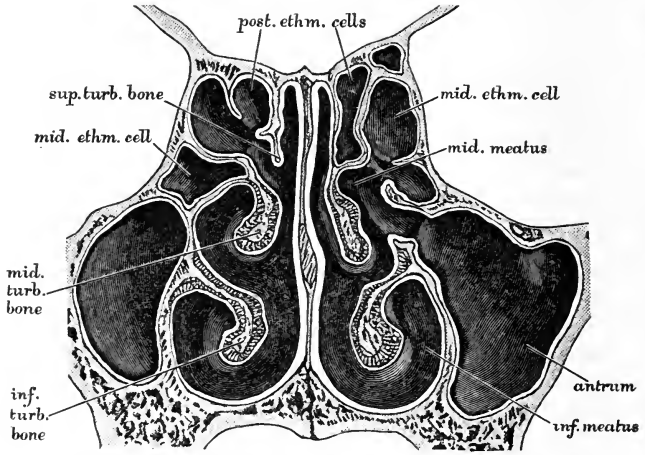


FIG. 235.—THE NASAL FOSSÆ IN CORONAL SECTION.

On the right side of the figure the section passes through the openings of the middle ethmoidal cells and the antrum into the middle meatus: on the left side, a section of the hinder part of the fossa is represented, and the posterior ethmoidal cells are seen opening into the superior meatus.

palate bone, at the posterior part. In the dried skull many apertures exist in it; most are in the ethmoid bone for the branches of the olfactory nerve with vessels, and one for the nasal nerve and vessels; on the front of the body of the sphenoid is the opening of its sinus.

Floor.

The FLOOR is slightly hollowed from side to side, and is formed by the palate processes of the superior maxillary and palate bones. Near the front in the dry skull is the incisor foramen leading to the anterior palatine fossa.

Inner boundary

The INNER WALL (septum nasi) is partly osseous and partly cartilaginous. The osseous part is constructed by the vomer, by the perpendicular plate of the ethmoid bone, and by those parts of the frontal and nasal with which this last bone articulates. The

angular space in front in the macerated skull is filled in the recent state by the *cartilage of the septum*, which forms part of the partition between the nostrils, and supports the lateral cartilages. Fixed between the vomer, the ethmoid, and the nasal bones, this cartilage rests in front on the incisor crest of the superior maxillæ, and projects between the cartilages of the nostrils. The septum nasi is commonly bent to one side. partly cartilaginous.

The OUTER WALL has the greatest extent and the most irregular surface. Seven bones enter into its formation, and they come in the following order from before backwards:—the nasal and superior maxillary; the small lachrymal bone and the lateral mass Outer boundary,

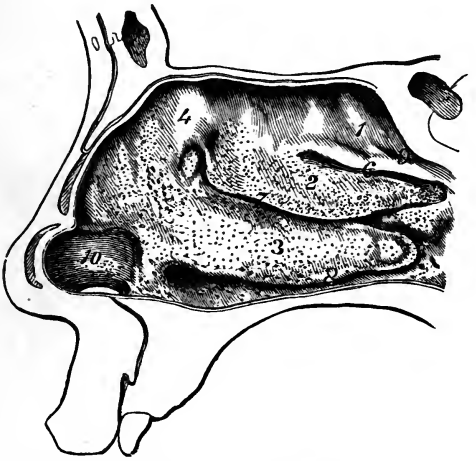


FIG. 236.—OUTER WALL OF THE NASAL CAVITY.

1. Upper turbinate bone.
2. Middle turbinate bone.
3. Inferior turbinate bone.
4. Flat part of the ethmoid bone.
6. Upper meatus.
7. Middle meatus.
8. Lower meatus.
9. Rudimentary fourth meatus.
10. Vestibule. The cut also shows the apertures of the glands of the nose.

of the ethmoid, with the inferior turbinate bone below these; and posteriorly the ascending part of the palate bone, with the internal pterygoid plate of the sphenoid; of these, the nasal, lachrymal, and ethmoid reach only about half way from roof to floor, and the inferior turbinate is confined to the lower half, while the others extend the whole depth. In front of the bones, the lateral cartilages complete this boundary. formed of many bones,

From this wall three slightly convoluted osseous plates, named *turbinate* or *spongy bones* (fig. 236), project into the cavity:—the upper (1) and middle (2) are processes of the ethmoid, but the lower one (3) is a separate bone. The turbinate bones are confined to that portion of the outer wall which is situate above the hard palate. is irregular on surface; presents spongy bones and hollows.

Between each turbinate bone and the wall of the nose is a longitudinal hollow or *meatus;* and into these hollows the nasal duct and the sinuses of the surrounding bones open.

Meatuses. The *meatuses* are the spaces arched over by the spongy bones ; and as the bones are limited to a certain part of the outer wall, so are the spaces beneath them.

Upper meatus. The *upper meatus* (fig. 236, 6) is the smallest and straightest of the three, and is limited to the posterior half of the space above the hard palate. Into its fore part the posterior ethmoidal cells open (figs. 235 and 237), and at its posterior end, in the dried skull, is

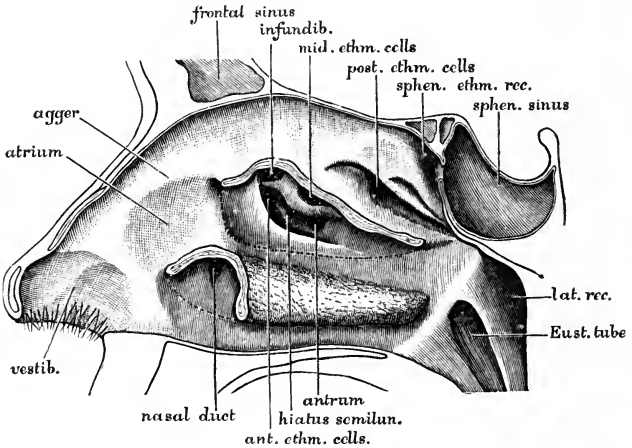


FIG. 237.—OUTER WALL OF RIGHT NASAL FOSSA.

The whole of the middle, and the fore part of the lower turbinate bones have been cut away, to show the openings in the middle and inferior meatuses.

the spheno-palatine foramen by which nerves and vessels enter the nose.

Middle meatus. The *middle meatus* (fig. 236, 7) is longer than the upper, and reaches from the posterior opening of the nasal fossa, nearly as far forwards as the hard palate. The free border of the middle turbinate bone being curved upwards anteriorly, this meatus is open in front as well as below. On raising, or cutting away, the overhanging turbinate bone (fig. 237), a deep groove, *hiatus semilunaris*, will be seen in the fore part of the lateral wall of the meatus, bounded below by the uncinate process of the ethmoid, and leading upwards through the *infundibulum* of the latter bone to the frontal sinus. Into the groove lower down the *anterior ethmoidal* cells open, and at its hindmost part is a small aperture leading into the *antrum* of the superior maxilla. Above the hiatus is a crescentic enlargement (the *ethmoidal bulla*), above which is an opening leading into the middle

Hiatus semilunaris.

Ethmoidal bulla.

ethmoidal cells; and in some cases there is a second opening into the antrum close above the lower turbinate bone.

Lower meatus.

The *inferior meatus* (fig. 235), is wider than the middle one, and extends the whole length of the hard palate. Near its anterior extremity is the opening of the nasal duct (fig. 237).

Spheno-ethmoidal recess.

Above the superior meatus, in an angle formed by the roof, there is a vertical depression called the *spheno-ethmoidal* recess (fig. 237), on the posterior wall of which the sphenoidal sinus opens; and occasionally a small fourth meatus, communicating with a posterior ethmoidal cell, is present between the recess and the superior meatus.

A fourth meatus sometimes.

Agger nasi, and atrium.

In front of the attached border of the middle turbinate bone there is usually to be seen a faint ridge, the *agger nasi* (fig. 237), directed obliquely downwards and forwards, and forming the upper boundary of a slight hollow known as the *atrium of the middle meatus* (fig. 237).

Nares.

The *nares*. In the recent condition of the nose each fossa has a distinct anterior opening on the face, and another in the pharynx; but in the skeleton there is only one common opening in front for both sides. These apertures and their boundaries have been before described in the anatomy of the face.

Mucous lining of the nose.

The MUCOUS LINING OF THE NASAL FOSSÆ is called the *pituitary* or *Schneiderian membrane*, and is blended with the subjacent periosteum or perichondrium. It is continuous with the skin at the nostril, with the membrane lining the pharynx through the posterior nares, and with the conjunctiva through the nasal duct; and it sends prolongations to line the different sinuses, viz., frontal, ethmoidal, sphenoidal, and maxillary.

Some foramina closed, others diminished by it.

The apertures in the dry bone which transmit nerves and vessels, viz., the incisor and spheno-palatine foramina, the holes in the cribriform plate, and the foramen for the nasal nerve and vessels, are entirely closed by the membrane; and the openings leading to the sinuses are reduced in size by the prolongations passing through them. At the termination of the nasal duct the mucous membrane forms a single or double fold, which is sometimes sufficient to close the opening and prevent air entering the canal from the nose.

Folds on spongy bones.

Over the middle and lower turbinate bones (to a greater extent on the latter) the mucous membrane is thickened and projected beyond the edges of the bones by the large submucous vessels, so that the meatuses are deeper and longer in the recent state than in the dried skull.

Three regions of nasal fossa.

The appearance and structure of the lining membrane differ in the upper and lower parts of the nasal fossa, and near the anterior opening, whence a division of the cavity is made into three portions, which are termed respectively the olfactory region, the respiratory region, and the vestibule.

Vestibule.

The *vestibule* (fig. 237) is the slightly dilated portion of the cavity immediately within the nostril. It is bounded by the cartilage of the aperture and the ala of the nose; and its wall is more flexible than that of the part above. The lining membrane of

the vestibule has the characters of the outer skin, being furnished with papillæ and hairs (vibrissæ), and lined by a stratified scaly epithelium.

Respiratory region.

The *respiratory region* is the part below the level of the middle turbinate bone. Its mucous membrane is thick, of a red colour, very vascular, and has numerous mucous glands, the openings of which are readily seen on the surface. The glands are largest and most abundant on the inferior turbinate bone, and at the lower and back part of the cavity. The epithelium of this region is columnar and ciliated.

Olfactory region.

The *olfactory region* is the narrowed upper part of the nasal fossa, which is enclosed by the ethmoid bone. It comprises the part of the

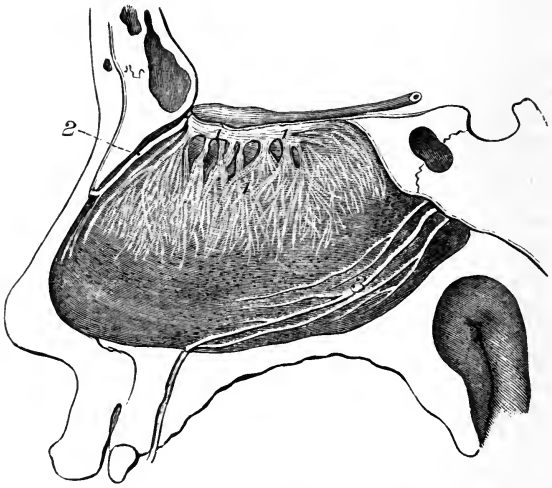


FIG. 238.—NERVES OF THE SEPTUM OF THE NOSE.

1. Olfactory bulb and inner set of olfactory nerves.
2. Nasal nerve of the ophthalmic trunk.
3. Naso-palatine nerve from Meckel's ganglion (too large in the figure).

roof formed by the cribriform plate, the part of the septum (about one-third) formed by the perpendicular plate of the ethmoid, and, on the outer wall, the upper and middle turbinate bones, together with the flat surface of the lateral mass of the ethmoid in front of the former. Over this region the olfactory nerves are distributed, and it is, therefore, the seat of the sense of smell. The olfactory mucous membrane is thinner, softer, and less vascular than that in the respiratory region, and it has in the fresh state a yellowish colour. Its epithelium is columnar, but not ciliated; and it is thickly beset with simple tubular glands.

Mucous membrane in sinuses.

In the sinuses the mucous lining is thin and pale, and its glands are few and small.

Dissection. At this stage of the dissection, but little will be seen of the distribution of the olfactory nerves. If the bony and cartilaginous septum be removed, so as to leave entire the membrane covering it on the left side, the nervous filaments will appear on the surface, near the cribriform plate. In the membrane, near the front of the septum, an offset of the nasal nerve is to be found. Dissection of nerves and vessels.

The naso-palatine nerve and artery (fig. 238, [3]) are to be sought lower down, as they are directed from behind forwards, towards the anterior palatine fossa; the artery is readily seen, especially if it is injected, but the fine nerve is embedded in the membrane, and will be found by scraping with the point of the scalpel.

By cutting through the fore and upper part of the membrane detached from the septum nasi, other branches of the olfactory nerve may be traced on the outer wall of the nasal fossa.

The OLFACTORY NERVES spring from the under surface of the olfactory bulb as it lies on the cribriform plate of the ethmoid bone (fig. 238, [1]), and descend to the olfactory region of the nose through the apertures in this part of the roof. They are about twenty in number, and are divided into two sets. Those of the *inner set* are the larger, and run downwards in the grooves on the perpendicular plate of the ethmoid, to be distributed over the upper third of the septum. The *outer set* (fig. 239, p. 675) ramifies over the upper turbinate bone, the flat surface of the ethmoid in front of this, and the fore part of the middle turbinate bone. As the nerves leave the skull, they receive sheaths from the dura mater and pia mater, which are continued as far as their terminal ramifications, and then become lost in the surrounding tissue. The trunks break up into tufts of filaments which communicate freely together, forming a close network beneath the mucous membrane. The olfactory nerves consist wholly of non-medullated fibres. Olfactory nerves: inner set; outer set.

The other nerves in the nose will be described in the following section.

Blood-vessels. The different vessels of the nose will be described in the next section, p. 677 *et seq.* The *arteries* form a network in the pituitary membrane, and a large submucous plexus on the edge of each of the two lower spongy bones, especially on the inferior. The *veins* have a plexiform disposition like the arteries, and this is largest on the lower spongy bone and the septum nasi. Blood-vessels of nose, arteries, veins.

SECTION XIII.

SPHENO-PALATINE AND OTIC GANGLIA, THE FINAL BRANCHES OF THE INTERNAL MAXILLARY VESSELS, THE FACIAL NERVE AND THE INTERNAL CAROTID ARTERY IN THE TEMPORAL BONE.

The preparation of Meckel's ganglion and its branches (fig. 239), and of the terminal branches of the internal maxillary artery, is a difficult task, in consequence of the nerves and vessels being Meckel's ganglion.

contained in osseous canals which require to be opened. The branches are first to be sought, and these are then to be followed to the ganglion and the main trunk.

Dissection

Dissection. The left half of the head is to be used for the display of Meckel's ganglion and its branches ; but the students will derive advantage from first attempting the dissection on the remains of the right side.

of palatine and

To lay bare the branches to the palate, detach the soft parts in the roof of the mouth from the bone, until the nerves and vessels escaping from the posterior palatine canals are arrived at. Cut off, with the bone forceps, the posterior part of the hard palate to a level with the vessels and nerves ; and cleaning these, trace offsets behind into the soft palate, and follow the main pieces forwards to the front of the mouth.

nasal branches ;

Take away, without injury to the naso-palatine nerve and vessels (already found), the hinder portion of the loose piece of mucous membrane detached from the septum nasi ; and separate the mucous membrane from the outer wall of the nasal fossa, behind the spongy bones, as high as the spheno-palatine foramen. In reflecting forwards the membrane, vessels and nerves will be seen entering it through the foramen ; but these may be left for the present, and directions for their dissection will be subsequently given. When the lining membrane of the nose has been removed behind the spongy bones, the palatine nerves and vessels will appear through the thin translucent palate bone, and may be readily reached by breaking carefully through the latter with a chisel. Afterwards the tube of membrane containing the palatine vessels and nerves being opened, these are to be followed down to the soft palate and the roof of the mouth, and upwards to the ganglion which is close to the body of the sphenoid bone.

body of ganglion ;

To bring Meckel's ganglion fully into view, it will be necessary to saw through the overhanging body of the sphenoid bone, to cut away pieces of the bones surrounding the hollow in which it lies and to remove with care the enveloping fat and the periosteum. The ganglion then appears as a flattened reddish-looking body, from which the Vidian and pharyngeal nerves pass backwards. Besides these branches, the student should seek two large nerves from the top of the ganglion which join the superior maxillary trunk, and smaller offsets to the floor of the orbit.

Vidian nerve.

To trace backwards the Vidian branch to the carotid plexus and the facial nerve, the student must lay open the Vidian canal in the root of the pterygoid process ; and in doing this he must define the small pharyngeal branches of nerve and artery which are superficial to the Vidian, and lie in the pterygo-palatine canal. At the back of the Vidian canal, a small branch from the nerve to the plexus on the internal carotid artery is to be looked for. Lastly, the prolongation of the Vidian nerve (large superficial petrosal) is to be followed into the skull through the dense tissue in the foramen lacerum, after cutting away the apex of the petrous portion of the temporal bone,

and dividing the internal carotid artery ; and it is to be pursued on the surface of the temporal bone, beneath the ganglion of the fifth nerve, to the hiatus Fallopii. Its junction with the facial nerve will be seen with the dissection of that nerve.

The branches of the ganglion to the nose will be found entering the outer surface of the detached mucous membrane opposite the spheno-palatine foramen, with corresponding arteries. One of these nerves (naso-palatine), dissected before in the membrane of the septum, is to be isolated, and to be followed forwards to where it enters the floor of the nose. The branches of the internal maxillary artery with the nerves are to be cleaned at the same time. Seek branches to the nose.

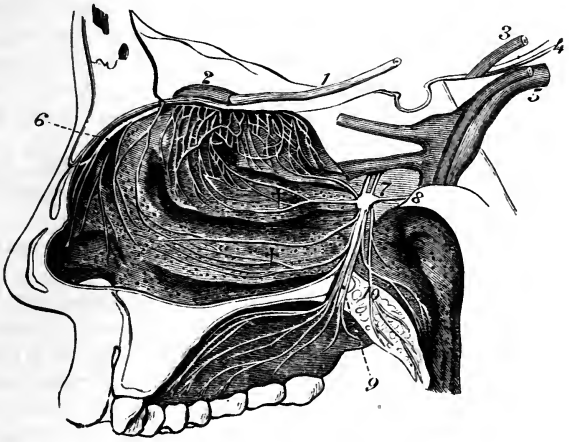


Fig. 239.—Nerves of the Outer Wall of the Nose and of the Palate.

1. Olfactory tract.
2. Olfactory bulb giving branches to the nose.
3. Third nerve.
4. Fourth nerve.
5. Fifth nerve.
6. Nasal nerve of the ophthalmic.
7. Meckel's ganglion.
8. Vidian nerve.
9. Large palatine nerve.
10. Small palatine nerve.
†† Nasal branches.

The SPHENO-PALATINE or MECKEL'S GANGLION (fig. 239, 2) lies in the spheno-maxillary fossa, close to the spheno-palatine foramen, and is connected with the branches of the superior maxillary nerve to the palate. The ganglionic mass is somewhat triangular in form, and of a reddish grey colour. It is situate, for the most part, behind the branches (spheno-palatine) of the superior maxillary nerve, so as to surround only some of their fibres ; and it is prolonged posteriorly into the Vidian nerve. Meckel's ganglion resembles the other ganglia in connection with the fifth nerve in having sensory, motor, and sympathetic offsets or roots connected with it. Ganglion of Meckel : situation and connection with fifth nerve ; composition ;

The BRANCHES of the ganglion are distributed chiefly to the nose and palate, but small offsets are given to the pharynx and the orbit. Other offsets or roots connect it with surrounding nerves. branches.

Nasal branches are—

BRANCHES TO THE NOSE. The nasal branches, from three to five in number, are very small and soft, and pass inwards through the spheno-palatine foramen; they are distributed in the nose and the roof of the mouth.

superior nasal,

1. The *superior nasal branches* ramify in the mucous membrane on the two upper spongy bones, and a few filaments reach the back part of the septum nasi.

naso-palatine.

The *naso-palatine nerve* (fig. 238, [3], p. 672), crosses the roof of the nasal fossa to reach the septum, on which it descends to near the front of that partition. In the floor of the nose it enters a special canal by the side of the septum, the left being anterior to the right, and is conveyed to the roof of the mouth, where it lies in the centre of the anterior palatine fossa. Finally, the nerves of opposite sides are distributed in the mucous membrane behind the incisor teeth, and communicate with one another. On the septum nasi filaments are supplied by the naso-palatine nerve to the mucous membrane. To follow the nerve to its termination, the canal in the roof of the mouth must be opened.

Palatine branches

BRANCHES IN THE PALATE. The nerves of the palate, though connected in part with the ganglionic mass, are the continuation of the spheno-palatine branches of the superior maxillary nerve (p. 652).

are three.

Below the ganglion they are divided into three—large, small, and external.

Large nerve has branches to nose;

1. The *large* or *anterior palatine nerve* (fig. 239, [9]) reaches the roof of the mouth through the largest palatine canal, and courses forwards nearly to the incisor teeth, where it joins the naso-palatine nerve. While in the canal, the nerve furnishes two or more filaments (*inferior nasal*, †) to the membrane on the middle and lower spongy bones; in the roof of the mouth it supplies the mucous membrane and glands, and gives an offset to the soft palate.

small; and

2. The *small* or *posterior palatine nerve* ([10]) lies in the smaller canal, and ends below in the soft palate, the uvula, and the tonsil.

external palatine.

3. The *external palatine nerve* is very small, and descends in the canal of the same name to be distributed to the velum palati and the tonsil.

Pharyngeal branch.

The PHARYNGEAL BRANCH is a minute twig which is directed through the pterygo-palatine canal to supply the mucous membrane of the pharynx near the Eustachian tube.

Orbital branches.

BRANCHES TO THE ORBIT. Two or three in number, these ascend through the spheno-maxillary fissure, and end in the periosteum and orbital muscle (p. 652). It will be necessary to cut through the sphenoid bone to follow these nerves to their termination.

Uniting branches, to fifth,

CONNECTING BRANCHES. The ganglion is united, as before said, with the spheno-palatine branches of the fifth nerve (fig. 239, 7), receiving sensory fibres through them; and through the medium of the Vidian, which is described below, it communicates with a motor nerve (facial), and with the sympathetic nerve.

and to facial and sympathetic through the Vidian.

The *Vidian nerve* ([8]) passes backwards through the Vidian canal, and sends some small filaments through the bone to the membrane

at the back of the roof of the nose (*upper posterior nasal branches*). At its exit from the canal, the nerve receives a soft reddish offset (*large deep petrosal nerve*) from the sympathetic on the outer side of the carotid artery. The continuation of the nerve enters the cranium through the foramen lacerum, and is directed backwards in a groove on the surface of the petrous part of the temporal bone, where it takes the name of *large superficial petrosal nerve* (fig. 240, [2], p. 678). Lastly it is continued through the hiatus Fallopii, to join the geniculate ganglion of the facial nerve (p. 679).

Vidian a compound nerve.

The Vidian nerve is supposed to consist of motor and sympathetic fibres in the same sheath, as in the connecting branches between the sympathetic and spinal nerves.

Directions. The students may now give their attention to the remaining nerves in the nasal cavity.

Seek other nerves and

Dissection. The nasal nerve is to be sought behind the nasal bone (fig. 239) by gently detaching the lining membrane, after having cut off the projecting bone. A branch is given from the nerve to the septum, but probably this, and the trunk of the nerve, will be seen but imperfectly in the present condition of the part.

vessels of nose.

The terminal branches of the internal maxillary artery in the spheno-maxillary fossa have been laid bare in the dissection of Meckel's ganglion, but they may be now completely traced out.

Nasal nerve lies beneath nasal bone; gives

The NASAL NERVE (of the ophthalmic) (fig. 239, [6]) has been already seen in the skull and orbit. Entering the nasal fossa by an aperture at the front of the ethmoid bone, the nerve gives a branch to the membrane of the septum, and then descends in a groove on the back of the nasal bone. At the lower margin of the latter it escapes between the bone and the upper lateral cartilage to the surface of the nose.

branch to septum,

BRANCHES. The *branch to the septum* (fig. 238) divides into filaments that ramify on the anterior part of that partition, and reach nearly to the lower border.

and to outer wall.

One or *two filaments* are likewise furnished by the nerve to the mucous membrane on the outer wall of the nasal fossa: these extend as low as the inferior spongy bone.

Branches of internal maxillary artery are

TERMINAL BRANCHES OF THE INTERNAL MAXILLARY ARTERY. The branches of the artery in the spheno-maxillary fossa, which have not been examined, are the superior palatine, nasal, pterygo-palatine, and Vidian.

palatine branch;

The *superior* or *descending palatine* is the largest branch, and accompanies the large palatine nerve through the posterior palatine canal, and along the roof of the mouth; it anastomoses behind the incisor teeth with its fellow, and with the naso-palatine branch through the incisor foramen. This artery supplies offsets to the soft palate and tonsil through the other palatine canals, and some twigs are furnished to the lining membrane of the nose. In the roof of the mouth the mucous membrane, glands and gums receive their vessels from it.

nasal branches,

The *nasal* or *spheno-palatine artery* enters the nose through the spheno-palatine foramen, and divides into branches. Some of these (*lateral nasal*) are distributed on the spongy bones, and the outer wall of the nasal fossa, and supply offsets to the posterior ethmoidal cells. One long branch, *naso-palatine* or *artery of the septum nasi*, runs on the partition between the nasal fossæ to the incisor foramen, through which it anastomoses with the descending palatine in the roof of the mouth; this branch accompanies the naso-palatine nerve, and covers the septum with numerous ramifications.

one to septum nasi;

pterygo-palatine branch;

The *pterygo-palatine* is a very small branch which, passing backwards through the canal of the same name, is distributed to the lining membrane of the pharynx.

Vidian branch.

The *Vidian* or *pterygoid branch* is contained in the Vidian canal with the nerve of the same name, and ends on the mucous membrane of the Eustachian tube and the upper part of the pharynx.

Other nasal arteries.

Some small *nasal arteries* are furnished to the roof of the nasal fossa by the posterior ethmoidal branch of the ophthalmic (pp. 647, 648). Also the *anterior ethmoidal* (internal nasal) enters the cavity with the nasal nerve, and ramifies in the lining membrane of the fore part of the nasal chamber as low as the vestibule; a branch passes to the face between the nasal bone and the cartilage with the nerve. Other offsets from the *facial artery* supply the nose near the nostril.

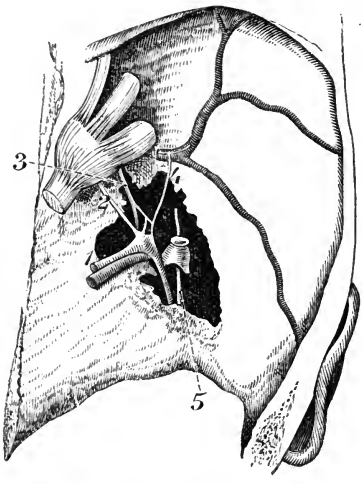


Fig. 240.—Facial Nerve in the Temporal Bone.

1. Facial nerve.
2. Large superficial petrosal.
3. Small superficial petrosal from Jacobson's nerve.
4. External superficial petrosal.
5. Chorda tympani of the facial.

Veins to alveolar plexus.

Veins. The veins accompanying the terminal branches of the internal maxillary artery enter the alveolar plexus in the spheno-maxillary fossa. Beneath the mucous membrane of the nose the veins have a plexiform arrangement, as before said.

Facial nerve.

Facial Nerve in the Temporal Bone (fig. 240). This nerve winds through the petrous part of the temporal bone; and it is followed with difficulty in consequence of the extreme density of the bone, and the absence of marks on the surface to indicate its position. To render this dissection easier, the student should be provided, for comparison, with a temporal bone, in which the course of the facial nerve and the cavity of the tympanum are displayed.

Dissection. *Each student may now work on his own side.* The trunk of the nerve is to be found as it leaves the stylo-mastoid foramen, and from this point it is to be followed upwards through the temporal bone. With this view, the side of the skull should be sawn through vertically between the meatus auditorius externus and the anterior border of the mastoid process, so as to open the lower part of the aqueduct of Fallopius from behind. The nerve will be then seen entering deeply into the substance of the temporal bone; and it can be followed forwards by cutting away with the bone-forceps all the bone projecting above it. In this last step the cavity of the tympanum will be opened, and the chain of bones in it exposed. Dissection of nerve in the bone,

The nerve is to be traced onwards along the inner side of the tympanum, until it becomes enlarged, and bends suddenly inwards to the meatus auditorius internus. The surrounding bone is to be removed from the enlargement, so as to allow of the petrosal nerves being traced from it; and the internal meatus is to be laid open, to see the facial and auditory nerves in that canal. and its genu;

The course of the chorda tympani nerve (branch of the facial) across the tympanum will be brought into sight by the removal of the central ear bone, the incus. This nerve may be also followed to the facial through the wall of the cavity behind, as well as out of the cavity in front. of chorda tympani;

The remaining branches of the facial nerve in the bone are very minute, and are not to be seen except on a fresh piece of the skull which has been softened in acid. The student may, therefore, omit the paragraphs marked with an asterisk, until he is able to obtain a part on which a careful examination can be made. and other branches.

The FACIAL NERVE (fig. 240, 1), traverses the internal auditory meatus, and entering the aqueduct of Fallopius at the bottom of that hollow, is conducted through the temporal bone to the stylo-mastoid foramen, and the face. In its serpentine course through the bone, the nerve is first directed outwards to the inner wall of the tympanum; at that spot it bends backwards, and is marked by a ganglionic swelling—*geniculate ganglion*, with which several small nerves are united. From this swelling the nerve is continued at first backwards and then downwards through the arched aqueduct, to the aperture of exit from the bone. Facial nerve winds through temporal bone, is marked by swelling which gives off twigs.

The *branches* of the nerve in the bone serve chiefly to connect it with other nerves; but one supplies the tongue, and another the stapedius muscle, but the branches marked thus * will not be seen except on a specially prepared part as described on p. 812.

* *Connecting branches* unite the facial with the auditory and glosso-pharyngeal nerves, with Meckel's ganglion, and with the lingual branch of the inferior maxillary nerve. Branches joining nerve

* *Union with the auditory nerve.* In the bottom of the meatus the facial and auditory nerves are connected by one or two minute filaments. to auditory,

Connecting branches of the geniculate ganglion. From the convexity of the swelling on the facial nerve three small branches

to Meckel's ganglion, tympanic of glosso-pharyngeal, and sympathetic;

proceed. One is the *large superficial petrosal nerve* (2), passing to the Vidian; another is a filament* of communication with the small superficial petrosal nerve of the tympanic plexus (3); and the third is the *external superficial petrosal nerve** (4), which unites the ganglion with the sympathetic on the middle meningeal artery.

nerve to stapedius;

* The *branch of the stapedius muscle* arises at the back of the tympanum, and is directed forwards to its muscle.

chorda tympani to lingual.

Chorda tympani. This long but slender branch of the facial nerve crosses the tympanum, and ends in the tongue. Arising about a quarter of an inch from the stylo-mastoid foramen, it enters the tympanum below the pyramid. In the cavity (fig. 240,5) the nerve is directed forwards across the handle of the malleus and the membrana tympani to an aperture on the inner side of the Glaserian fissure, through which it leaves the tympanum.

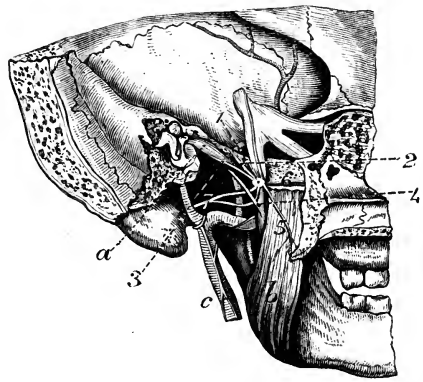


FIG. 241.—THE OTIC GANGLION FROM THE INNER SIDE.

a. Tensor tympani muscle.
b. Internal pterygoid muscle.
c. External carotid artery with the sympathetic on it.
1. Otic ganglion.
2. Small superficial petrosal nerve.
3. Nerve to tensor tympani.
4. Chorda tympani joining lingual.
5. Nerve to internal pterygoid.
6. Nerve to tensor palati.
7. Auriculo-temporal nerve.

Outside the skull the chorda tympani joins the lingual nerve, and continues along it to the submaxillary ganglion and the tongue (p. 625).

Auditory nerve.

The AUDITORY NERVE will be learnt with the ear. Entering the internal auditory meatus with the facial nerve, it divides into an upper smaller, and a lower larger part, which are distributed to the membranous labyrinth.

Otic ganglion.

OTIC GANGLION. At this stage of the dissection there is little to be seen of the ganglion, but the student should keep in mind that it is one of the things to be examined in a fresh part. Its situation is on the inner aspect of the inferior maxillary nerve, immediately below the foramen ovale, and it adheres closely to the trunk of the nerve.

Dissection to find it,

Dissection (fig. 241). Putting the part in the same position as for the examination of Meckel's ganglion, the dissector should define the Eustachian tube and the muscles of the palate, and then take away the levator palati and the cartilaginous portion of the tube,

using much care in removing the latter. When some loose areolar tissue has been cleared away, the internal pterygoid muscle (*b*) comes into view, with the trunk of the inferior maxillary nerve above it; and a branch descending from that nerve to the internal pterygoid muscle. If the nerve to the pterygoid be taken as a guide, it will lead to the ganglion.

to define ganglion and its branches.

To complete the dissection, saw vertically through the petrous part of the temporal bone near the inner wall of the tympanum, the bone being supported while it is divided. Taking off some membrane which covers the ganglion, the student may follow backwards a small branch to the tensor tympani muscle; but he should open the small tube that contains the muscle, by entering it below through the carotid canal. Above this small branch there is another minute nerve (small superficial petrosal), which issues from the skull, and joins the back of the ganglion. A small twig is to be sought from the front of the ganglion to the tensor palati muscle; and other minute filaments to join the sympathetic nerve on the large meningeal artery and the chorda tympani.

Otic ganglion is on inner side of inferior maxillary nerve.

The OTIC GANGLION (Arnold's ganglion; fig. 241) is a small reddish body, which is situate on the inner surface of the inferior maxillary nerve close to the skull, and surrounds the origin of the nerve to the internal pterygoid muscle. By its inner surface the ganglion is in contact with the Eustachian tube, and at a little distance behind lies the large middle meningeal artery. In this ganglion, as in the others connected with the fifth nerve, filaments from motor, sensory, and sympathetic nerves are blended. Some twigs are furnished by it to muscles.

Structure.

Branches join it with fifth,

Connecting branches—roots. Through its connection with the nerve to the internal pterygoid, the otic ganglion receives fibres from both the small and large roots of the inferior maxillary nerve, so that it may be said to derive its motor and sensory roots from the fifth. Its sympathetic root comes from the plexus on the middle meningeal artery. The ganglion is farther joined behind by the small superficial petrosal nerve (2), through which fibres are conveyed to it from the facial and glosso-pharyngeal nerves. One or two short branches pass between the ganglion and the beginning of the auriculo-temporal nerve; and a filament descends to the chorda tympani.

sympathetic,

seventh,

ninth,

auriculo-temporal, and chorda tympani.

Branches to muscles; tensor tympani and tensor palati.

Branches to muscles. Two muscles receive their nerves through the otic ganglion, viz., tensor tympani and tensor palati. The *nerve to the tensor tympani* (3) is directed backwards to gain the bony canal lodging the muscle. The *branch for the tensor palati* (6) arises from the front of the ganglion, and enters the outer surface of its muscle. The fibres of these branches are derived mainly from the internal pterygoid nerve.

Nerve of internal pterygoid.

The *nerve of the internal pterygoid muscle* (5) arises from the inner side of the inferior maxillary nerve near the skull, and penetrates the deep surface of the muscle. This nerve is formed almost entirely by an offset from the motor root of the fifth.

Expose the carotid artery.

The CAROTID CANAL. **Dissection.** The student should now complete the exposure of the internal carotid artery in the temporal bone by chipping away the outer wall of the canal, taking the artery as a guide. In cleaning the artery large, and rather red, branches of the superior cervical ganglion of the sympathetic will be seen if the part has been well kept; and, in a fresh part, a small filament from the tympanic branch of the glosso-pharyngeal may be seen to join the sympathetic at the posterior part of the canal, and another from the Vidian at the fore part.

The INTERNAL CAROTID ARTERY IN THE TEMPORAL BONE. The artery has a winding course in the bone; at first it ascends in front of the cochlea and tympanum; next it is directed forwards and inwards almost horizontally; and, lastly, it turns upwards into the cranium through the foramen lacerum. Branches of the sympathetic nerve and a venous plexus surround the vessel in the bone.

SECTION XIV.

DISSECTION OF THE TONGUE.

Directions.

Directions. The tongue and larynx are to remain connected with each other while the students learn the general form and structure of the tongue.

Dissection.

Dissection. The ends of the extrinsic lingual muscles that have been detached may be shortened, but enough of each should be left to trace it afterwards into the substance of the tongue.

Tongue: form and situation;

The TONGUE is an ovoid, somewhat flattened body, with the larger end turned backwards, which occupies the floor of the mouth, and forms a part of the anterior wall of the pharynx. It is free over the greater part of its surface; but at the back, and at the posterior two-thirds of the under surface, it is attached by muscles and mucous membrane to the parts around.

relations of apex, and base.

The tip of the tongue touches the incisor teeth. The base is attached to the hyoid bone, and is connected likewise with the epiglottis by three folds of mucous membrane—a central and two lateral.

Upper surface: body; root.

The upper surface or *dorsum* is convex, and in the anterior two-thirds of its extent is marked by a medium longitudinal groove or *raphé*, which terminates behind in a depression of variable depth, named the *foramen cæcum*. From the depression a slight lateral groove is directed outwards and forwards on each side for a short distance. The part of the tongue in front of the lateral grooves is distinguished as the *body*, and is received into the hollow of the roof of the mouth; its surface is covered with papillæ. The posterior third or *root* of the organ looks into the pharynx; and its surface is smoother, although rendered somewhat irregular by projecting mucous glands and groups of *lymphoid follicles*, and by small

apertures leading into recesses of the mucous membrane. The under surface, free only in part, gives attachment to the mucous membrane and to the different lingual muscles connected with the hyoid bone and the jaw. In front of the muscles the mucous membrane forms a fold in the middle line, termed the *frænum linguæ;* and on each side an irregular ridge—*plica fimbriata* (better seen in infants), runs forwards and inwards about midway between the frænum and the margin of the tongue towards the tip. Lower surface.

Each border of the tongue is joined opposite the lateral groove above mentioned by the fold of mucous membrane descending from the soft palate, and known as the anterior pillar of the fauces. Behind this fold, the root of the tongue is attached on each side to the wall of the pharynx; but in front the margin of the body is free. The free border is thick and rounded in its hinder part, where it is marked by vertical ridges and furrows, and becomes gradually thinner towards the tip. Borders.

Papillæ. On the dorsum of the tongue are the following kinds of papillæ; the conical and filiform, the fungiform, and the circumvallate. A hand lens may conveniently be used in the examination of them. Kinds of papillæ:

The *conical and filiform papillæ* are the numerous small projections which cover the anterior two-thirds of the dorsum of the tongue. They taper from the base towards the free extremity, where they are provided with smaller secondary papillæ; and many of them, especially towards the sides of the organ, have their epithelial covering produced into long hair-like processes, whence the name filiform is given to them. Towards their limit behind they are arranged in lines parallel to the lateral grooves, and on the sides they form vertical rows. conical filiform;

The *fungiform papillæ* are less numerous but larger than the preceding set, amongst which they are scattered, especially at the tip and sides of the tongue. They are wider at the free end than at the part fixed to the tongue, and project beyond the conical papillæ. Their surface is covered with small simple papillæ. fungiform;

The *circumvallate papillæ* are much larger than the foregoing, and are placed at the junction of the middle and posterior thirds of the tongue. Their number varies from seven to twelve. One, larger than the rest, is situate immediately in front of the foramen cæcum, and the others are disposed in two rows (one on each side) parallel to the lateral groove, so as to form a figure like a widely-spread letter V. Each papilla is attached by a constricted stem, which is surrounded by a groove; its wider end or base projects beyond the surface of the tongue, and is covered with small simple papillæ. Around the groove the mucous membrane forms a slightly prominent fold, which is also beset with secondary papillæ. circumvallate.

Structure. The tongue consists of two symmetrical halves separated by a fibrous layer in the median plane. Each half is made up of muscular fibres with interspersed fat; and entering it are Parts found in tongue.

the lingual vessels and nerves. The tongue is enveloped by mucous membrane; and a special fibrous layer attaches it to the hyoid bone.

Define septum,

Dissection. To define the septum, and the membrane attaching the tongue to the hyoid bone, the tongue is to be placed on its dorsum; and, the remains of the right mylo- and genio-hyoid muscles having been removed, the genio-glossi muscles are to be cleaned, and drawn from one another along the middle line. After

hyo-glossal membrane,

separating those muscles, and cutting across their intercommunicating fibres, the edge of the septum will appear. By tracing the hinder fibres of the genio-glossus muscle towards the hyoid bone, the hyo-glossal membrane will be arrived at.

and inferior lingualis.

On the outer side of the genio-glossus muscle is the longitudinal bundle of the inferior lingualis, which will be better seen subsequently.

Fibrous structures of tongue.

Fibrous tissue. Along the middle line of the tongue is placed a thin lamina of this tissue, forming a septum; the root of the tongue is attached by another fibrous structure, the hyo-glossal membrane; and covering the greater part of the organ is a submucous layer of the same tissue.

Septum.

Septum. This structure forms a vertical partition between the two halves of the tongue (fig. 243, B, p. 686), and extends from the base to the apex, but does not reach to the dorsum. It is thicker behind than in front, and is connected posteriorly with the hyo-glossal membrane. To each side the transverse muscle is attached. Its disposition may be better seen subsequently on a vertical section.

Hyo-glossal membrane.

The *hyo-glossal membrane* is a thin but strong fibrous lamina, which attaches the root of the tongue to the upper border of the body of the hyoid bone. On its under or anterior surface some of the hinder fibres of the genio-glossi are inserted, as if this was their aponeurosis to attach them to the hyoid bone.

Submucous layer.

The *submucous fibrous stratum* of the tongue invests the organ, and is continued into the sheaths of the muscles. Over the posterior third of the dorsum its strength is greater than elsewhere; and in front of the epiglottis it forms bands in the folds of the mucous membrane in that situation. Into it are inserted the muscular fibres which end on the surface of the tongue.

Muscles in each half:

Muscles. Each half of the tongue is made up of extrinsic and intrinsic muscles. The former or external are distinguished by

two kinds,

having only their termination in the tongue; and the latter, or internal, by having both origin and insertion within the organ—that is to say, springing from one part and ending at another.

Extrinsic: number.

The *extrinsic muscles* (fig. 242) are the following: palato-glossus, stylo-glossus, genio-glossus, hyo-glossus, chondro-glossus, and pharyngeo-glossus. Only the lingual endings of these, except in the case of the chondro-glossus, are now to be studied.

Dissection of palato-, stylo-, and hyo-glossus,

Dissection. After the tongue has been firmly fastened on its left side, the extrinsic muscles may be dissected on the right half. Three of these muscles, viz., palato- (D), stylo- (B), and hyo-glossus (C), come together to the side of the tongue; and, to follow their radiating

fibres inwards and forwards, it will be necessary to remove from the dorsum, between them and the tip, a thin layer consisting of the mucous membrane with the submucous fibrous tissue, and the fleshy fibres of the upper lingualis. Beneath the tip a junction between the stylo-glossus muscles of opposite sides is to be traced.

The piece of the constrictor muscle (G) which is attached to the tongue, and the ending of the genio-glossus will come into view on the division of the hyo-glossus. of pharyngeo-glossus,

To lay bare the chondro-glossus (F), which is a small muscular slip attached to the lesser cornu of the hyoid bone, turn upwards the dorsum of the tongue, and feel for the small cornu of the hyoid through the mucous membrane. Then remove the mucous membrane in front of this, and the fibres of the muscle radiating forwards will be visible. of chondro-glossus.

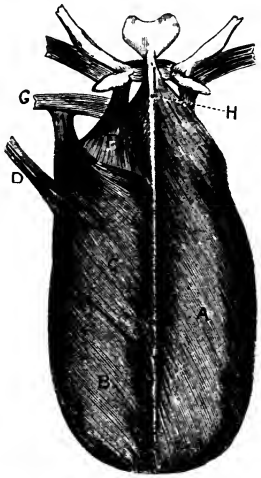


Fig. 242.—Muscles on the Dorsum of the Tongue. (After Zaglas.)

A. Superficial lingualis.
B. Stylo-glossus.
C. Hyo-glossus.
D. Palato-glossus.
F. Chondro-glossus.
G. Pharyngeo-glossus.
H. Septum linguæ.

The PALATO-GLOSSUS reaches the side of the tongue at the junction of the posterior and middle thirds. Its fibres are directed inwards, in part on the surface, and in part deeply with the transverse muscle of the septum. Palato-glossus in tongue.

The STYLO-GLOSSUS joins the body of the tongue below the foregoing, and is continued forwards as a gradually tapering bundle beneath the lateral margin to the tip of the organ, where it becomes united with the inferior lingualis, and meets the muscle of the opposite side. From its upper border fibres are directed inwards over the dorsum of the tongue to the middle line; and other bundles pass inwards from its lower edge between the fasciculi of the hyo-glossus. Stylo-glossus prolonged to tip of tongue; sends many fibres inwards.

The HYO-GLOSSUS enters the under surface of the tongue in its middle third, between the stylo-glossus and the inferior lingualis. Its fibres are collected into bundles which turn round the margin and form, with those of the preceding muscles, a layer on the dorsum of the tongue, the hinder fibres passing almost transversely inwards, the anterior inclining forwards to the tip. Hyo-glossus united with palato- and stylo-glossus.

The CHONDRO-GLOSSUS is a small fan-shaped muscle, which *arises* from the lesser cornu and the adjacent part of the body of the hyoid bone. Its fibres are directed forwards, spreading out beneath the mucous membrane of the posterior third of the tongue, and are *inserted* into the submucous layer. Chondro-glossus.

Muscular cortex of tongue.

Cortex of the tongue. The muscles above described, together with the superficial lingualis, constitute a cortical layer of oblique and longitudinal fibres, which covers the tongue, except below where the genio-glossus and inferior lingualis muscles are placed, and resembles "a slipper turned upside down" (Zaglas). This stratum is pierced by the deeper fibres.

Genio-glossus in the tongue;

The GENIO-GLOSSUS (fig. 243, A) enters the tongue vertically by the side of the septum and perforates the cortical covering to end in the submucous tissue. In the tongue the fibres spread like the rays of a fan from apex to base, and are collected into transverse laminæ as they pass through the transversalis. The hindmost fibres end on

its posterior fibres.

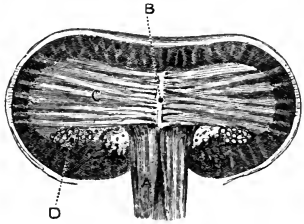
the hyo-glossal membrane and the hyoid bone; and a slip is prolonged from them, beneath the hyo-glossus, to the upper constrictor of the pharynx. A vertical section at a future stage will show the radiation of its fibres.

Constrictor in the tongue.

The PHARYNGEO-GLOSSUS (fig. 242, G), or the fibres of the upper constrictor attached to the side of the tongue, passes beneath the fibres of the hyo-glossus, and is continued with the transverse muscle to the septum.

Intrinsic muscles.

The *intrinsic muscles* are four in number in each half of the tongue, viz., transversalis, a superior and an inferior lingualis, and a set of perpendicular fibres.



First show inferior,

FIG. 243.—TRANSVERSE SECTION OF THE TONGUE.

A. Genio-glossus.
B. Septum linguæ.
C. Transversalis.
D. Inferior lingualis. (After Zaglas.)

Dissection. To complete the preparation of the inferior lingualis on the right side, the fibres of the stylo-glossus covering it in front, and those of the hyo-glossus over it behind are to be cut through.

then superior lingualis,

The superior lingualis (fig. 242, A) may be shown on the left side, by taking the thin mucous membrane from the upper surface from tip to base.

then transversalis.

The transversalis may be laid bare on the right side, by cutting away on the upper surface the stratum of the extrinsic muscles already seen; and by removing on the lower surface the inferior lingualis and the genio-glossus, after the former muscle has been examined.

Trace the nerves.

The nerves of the tongue are to be dissected on the left half as well as the part will admit; but a fresh specimen will be required to follow them satisfactorily.

Transversalis is horizontal: attachments;

The TRANSVERSE LINGUALIS MUSCLE (fig. 243, C) forms a horizontal layer in the substance of the tongue from base to apex. The fibres are attached internally to the side of the septum, and are directed thence outwards, the posterior being somewhat curved, to their insertion into the submucous tissue at the side of the tongue.

Its fibres are collected into flattened bundles, so as to allow the passage between them of the ascending fibres of the genio-glossus. fibres in laminæ;

Action. By the contraction of the fibres of the two muscles the tongue is made narrower and rounder, and is increased in length. use.

The SUPERIOR LINGUALIS (fig. 242, A) is a very thin layer of oblique and longitudinal fibres close beneath the submucous tissue on the dorsum of the tongue. Its fibres arise from the frænum epiglottidis, and from the fibrous tissue along the middle line; from this attachment they are directed obliquely outwards, the anterior becoming longitudinal, to the margin of the tongue at which they end in the submucous fibrous tissue. Superficial lingualis:

Action. Both muscles tend to shorten the tongue; and they will bend the point upwards. use.

The INFERIOR LINGUALIS (fig. 243, D) is much stronger than the preceding, and is placed on the under surface of the tongue, between the hyo-glossus and genio-glossus. The muscle *arises* behind from the fascia at the root of the tongue; and the fibres are collected into a roundish bundle: from its attached surface fasciculi are continued upwards through the transverse fibres to the dorsum; and at the anterior third of the tongue, where the muscle is overlaid by the stylo-glossus, some of the fibres are applied to that muscle and distributed with it. Lower lingualis: origin; ending;

Action. This muscle shortens the tongue, and bends the apex downwards. use.

The intrinsic PERPENDICULAR FIBRES are found near the border of the fore part of the tongue, and can be seen only in transverse sections. They pass from the submucous tissue of the dorsum downwards and somewhat outwards, decussating with the cortical and transverse fibres, to the under surface. Perpendicular muscle:

Action. By their contraction these fibres flatten and render broader the part of the tongue in which they occur. use.

Medullary portion of the tongue. The central part of the tongue, which is thus named, is paler in colour and softer than the cortex. It is composed mainly of the bundles of the transverse muscle crossing the laminæ of the genio-glossus internally and the perpendicular fibres externally, together with interspersed fat. Medulla of tongue.

The *mucous membrane of the tongue* is a continuation of that lining the mouth, and is provided with a stratified scaly epithelium. It invests the greater part of the tongue, and is reflected off at different points in the form of folds. At the epiglottis are three small *glosso-epiglottidean* folds, connecting this body to the root of the tongue; the central one of these is called the *frænum of the epiglottis.* It is furnished with numerous glands, and lymphoid crypts and follicles. Mucous membrane, its epithelium. Folds.

The *crypts* are depressions of the mucous membrane, which are surrounded by *lymphoid follicles* in the submucous tissue ("the *lingual tonsil*"), like the arrangement in the tonsil; they occupy the dorsum of the tongue between the circumvallate papillæ and the epiglottis, where they form a stratum close beneath the mucous membrane. Lymphoid tissue

and glands at the base;

The *lingual glands* are racemose, similar to those of the lips and cheek, and are placed beneath the mucous membrane on the dorsum of the tongue behind the circumvallate papillæ. A few are found in front of the circumvallate papillæ, where they project into the muscular substance. Some of their ducts open on the surface and others in the hollows around the circumvallate papillæ, or into the foramen cæcum and the depressions of the crypts.

glands at the side, and beneath tip.

Opposite the circumvallate papillæ, at the margin of the tongue, is a small cluster of mucous glands. Under the tip of the tongue, on each side of the frænum, is another elongated collection of the same kind of glands embedded in the muscular fibres, from which several ducts issue.

Nerves from three sources:

NERVES. There are three nerves on the under surface of each half of the tongue, viz., the lingual of the fifth, the hypoglossal, and the glosso-pharyngeal (fig. 224, p. 624).

lingual of fifth,

The *lingual nerve* sends upwards filaments through the muscular substance to the mucous membrane of the anterior two-thirds of the tongue, and supplies the conical and fungiform papillæ. Accompanying this nerve are the lingual fibres of the chorda tympani.

twelfth,

The *hypoglossal nerve* is spent in long slender offsets to the muscular substance of the tongue.

and ninth.

The *glosso-pharyngeal nerve* divides under the hyo-glossus into two branches. One turns to the dorsum, and ramifies in the mucous membrane behind the foramen cæcum, supplying also the circumvallate papillæ. The other passes to the side of the tongue, and ends in branches for the mucous membrane, extending forwards to about the middle of the border.

Arteries, veins, and lymphatics.

VESSELS. The *arteries* are derived from the lingual of each side: the *veins* pass to the internal jugular trunk. The *lymphatics* of the tongue for the most part pass backwards to the upper deep cervical glands, and have connected with them two or three small *lingual glands* on the outer surface of the hyo-glossus muscle; but some descend to the submaxillary lymphatic glands.

SECTION XV.

DISSECTION OF THE LARYNX.

General construction of larynx.

The LARYNX is the upper dilated part of the airtube, in which the voice is produced. It is constructed of several cartilages united together by ligamentous bands; of muscles for the movement of the cartilages; and of vessels and nerves. The whole is lined by mucous membrane.

Dissection.

Dissection. The tongue may be removed from the larynx by cutting through its root, but this is to be done without injuring the epiglottis.

The student will find it advantageous to study a museum preparation of the laryngeal cartilages as described in the next section (pp. 698 to 704) before beginning the dissection of the larynx.

The LARYNX is placed in the middle of the neck, in front of the pharynx, and in the resting condition opposite the fourth, fifth and sixth cervical vertebræ. It is however very moveable, its connections permitting especially a considerable degree of elevation, which comes into play in the act of swallowing. Situation varies.

Its form is pyramidal, the base being turned upwards and attached to the hyoid bone, while the apex joins the trachea. In length it measures, *in the male*, about an inch and three-quarters ; in width, at the top nearly as much, and at the lower end one inch ; while the greatest depth from before backwards is about an inch and a half. *In the female*, the average length is an inch and a half, and the depth one inch. Before the age of puberty the larynx is relatively very small. Form; and dimensions in male, in female, and in child.

On each side the larynx is covered by the depressor muscles of the hyoid bone, the carotid vessels, and the lateral lobes of the thyroid body. The front projects beneath the skin in the middle line of the neck ; and the posterior surface is covered by the mucous membrane of the pharynx. Relations.

MUSCLES. The sterno-thyroid and thyro-hyoid muscles, which, together with the stylo-pharyngeus and inferior constrictor of the pharynx, move the larynx as a whole, are frequently called the *extrinsic* muscles of the larynx. The *intrinsic* muscles are six pairs and one single muscle. Of these, one paired muscle is exposed on the side of the larynx ; two pairs and a single muscle are seen at the back ; and the rest are concealed by the thyroid cartilage. Muscles, extrinsic and intrinsic.

Directions. On one side of the larynx, say the right, the muscles may be dissected, and on the opposite side the nerves and vessels ; and the superficial muscles, which do not require the cartilages to be cut, are to be first learnt. Directions.

Dissection. The larynx being extended and fastened with pins, the dissector may clear away from the hyoid bone and the thyroid cartilage the following muscles, viz., omo-hyoid, sterno-hyoid, sterno-thyroid, thyro-hyoid, and inferior constrictor. Dissection

Along the side, between the thyroid and cricoid cartilages, the crico-thyroid muscle (fig. 245, 1) will be recognised. of the superficial muscles.

To denude the posterior muscles (fig. 244), it will be necessary to turn over the larynx, and to remove the mucous membrane covering it. On the back of the cricoid cartilage the dissector will find the posterior crico-arytenoid muscle (C) ; and above this, on the back of the arytenoid cartilages, the arytenoid muscle (B) will appear, with the crossing fasciculi of the aryteno-epiglottidean muscles (A) on its surface.

The CRICO-THYROID MUSCLE (fig. 245, 1) is fan-shaped, and is separated by a triangular interval from the one on the opposite side. It *arises* from the front and the lateral part of the cricoid cartilage ; and its fibres radiate to be *inserted* into the lower cornu, and the lower border of the thyroid cartilage as far forwards as a quarter of Crico-thyroid origin; insertion;

an inch from the middle line; as well as for a short distance into the inner surface of that cartilage. The muscle rests on the crico-thyroid membrane, and is concealed by the sterno-thyroid muscle.

use. *Action.* It draws the cricoid cartilage upwards and backwards, so as to increase the distance between the thyroid and the arytenoid cartilages, and thus tighten the vocal cords.

Posterior crico-arytenoid is on back of cricoid cartilage: The POSTERIOR CRICO-ARYTENOID MUSCLE (fig. 244, c) *arises* from the depression by the side of the vertical ridge at the back of the cricoid cartilage. From this origin the fibres are directed outwards and upwards, converging to their *insertion* into the muscular process at the outer side of the base of the arytenoid cartilage.

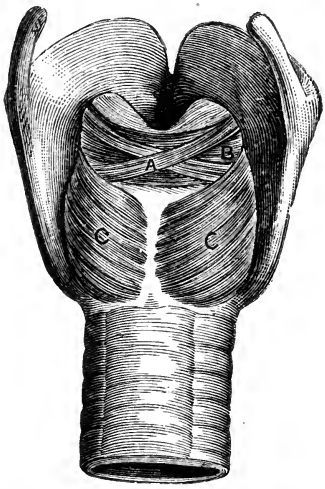


FIG. 244.—HINDER VIEW OF THE LARYNX.

A. Aryteno-epiglottidean muscle.
B. Arytenoid muscle.
c.c. Posterior crico-arytenoids.

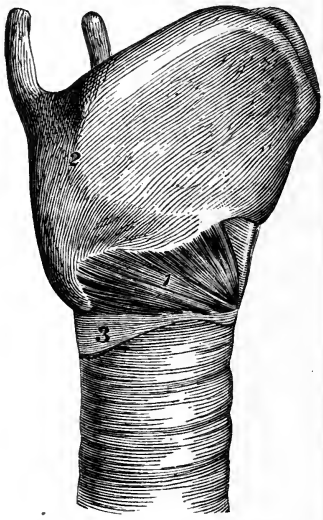


FIG. 245.—SIDE VIEW OF THE LARYNX.

1. Crico-thyroid muscle.
2. Thyroid cartilage.
3. Cricoid cartilage.

use. *Action.* It draws the arytenoid cartilage downwards and outwards to a slight extent, separating this from the one of the opposite side; but its principal action is to rotate the cartilage, turning outwards the vocal process, and thus dilating the glottis.

Kerato-cricoid. *Kerato-cricoid muscle* (Merkel). This is a small fleshy slip which is occasionally seen at the lower border of the preceding muscle. It arises from the cricoid cartilage, and is inserted into the back of the lower cornu of the thyroid cartilage.

Arytenoid muscle lies on back of arytenoid cartilages The ARYTENOID MUSCLE (fig. 244, B) is single, and extends across the middle line, closing the interval between the arytenoid cartilages behind. Its transverse fibres are attached on each side to the outer

part of the posterior surface of the arytenoid cartilage. On its hinder surface lie the aryteno-epiglottidean muscles; and the laryngeal mucous membrane covers it in front in the space between the cartilages.

Action. It draws together the arytenoid cartilages, rendering narrower the opening of the glottis. use.

The ARYTENO-EPIGLOTTIDEAN MUSCLES (A) are two small bundles which cross obliquely from one side to the other on the back of the arytenoid muscle. Each *arises* from the outer and lower part of the posterior surface of one arytenoid cartilage, and passes to the upper part of the outer border of the cartilage of the opposite side, where a few of the fibres are *inserted*, but the greater number turn round this border and end in the aryteno-epiglottidean fold of the mucous membrane, some reaching the margin of the epiglottis. A slip is also prolonged into the thyro-arytenoid muscle. The ending of the muscle will be seen later when the ala of the thyroid cartilage has been removed. Aryteno-epiglottidean muscles cross like letter X:

Action. These muscles bring together the tips of the arytenoid cartilages, and depress the epiglottis, thus assisting to close the upper aperture of the larynx in swallowing. use.

Dissection. The remaining muscles (fig. 246, p. 692) will be brought into view by removing the greater part of the right ala of the thyroid cartilage, by cutting through it a quarter of an inch from the middle line, after its lower cornu has been detached from the cricoid, and the crico-thyroid muscle taken away. By dividing next the thyro-hyoid membrane attached to the upper margin, the loose piece will come away on separating the subjacent areolar tissue from it. Dissection of internal muscles. Remove half of thyroid cartilage.

By the removal of some areolar tissue, the dissector will define inferiorly the lateral crico-arytenoid muscle; above it, the thyro-arytenoid muscle; and still higher, the pale fibres of the aryteno-epiglottidean and thyro-epiglottidean muscles in the fold of mucous membrane between the epiglottis and the arytenoid cartilage. On cleaning the fibres of the thyro-arytenoid near the front of the larynx, the top of the sacculus laryngis with its small glands will appear above the fleshy fibres. Position of muscles.

The LATERAL CRICO-ARYTENOID MUSCLE (fig. 246, [3]) *arises* from the upper border of the cricoid cartilage at the side, and is directed backwards to be *inserted* into the fore part of the muscular process of the arytenoid cartilage. It is concealed by the crico-thyroid muscle and the thyroid cartilage, and its upper border is contiguous to the succeeding muscle. Lateral crico-arytenoid muscle:

Action. It rotates inwards the arytenoid cartilage, opposing the posterior crico-arytenoid muscle, and bringing one vocal cord to the other, so as to narrow the glottis. use.

The THYRO-ARYTENOID MUSCLE (fig. 246, [4]) extends from the thyroid to the arytenoid cartilage; it is thick below, but thin and expanded above. The muscle *arises* from the thyroid cartilage near the middle line, for about the lower half of its depth, and from the crico-thyroid Thyro-arytenoid muscle

consists of outer and inner parts:

membrane. The fibres are directed backwards with different inclinations:—The *external* (4) ascend somewhat and are *inserted* into the outer border of the arytenoid cartilage. The *internal* fibres (8) are horizontal, and form a thick bundle which is *inserted* into the margins of the vocal process and the lower part of the outer surface of that cartilage, whilst a few of the deepest fibres of the muscle pass from the outer surface of the vocal process of the arytenoid cartilage to be inserted into the true vocal cord.

some fibres from arytenoid cartilage to vocal cord;

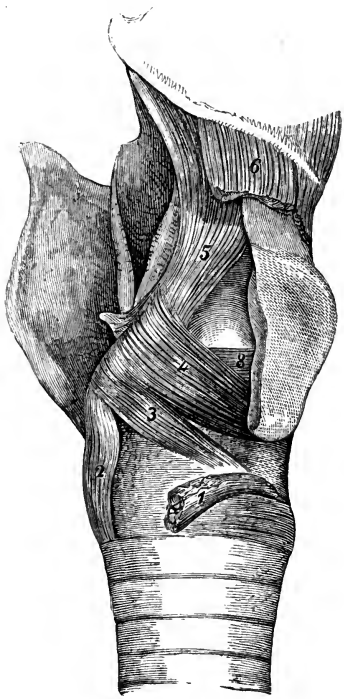


FIG. 246.—INTERNAL MUSCLES OF THE LARYNX.

1. Crico-thyroid detached.
2. Posterior crico-arytenoid.
3. Lateral crico-arytenoid.
4. Thyro-arytenoid, superficial part.
5. Depressor of the epiglottis, consisting of fibres of the aryteno-epiglottidean muscle and others given off from the thyro-arytenoid.
6. Thyro-hyoid, cut.
8. Deep part of thyro-arytenoid.

relations;

The outer surface of the muscle is covered by the thyroid cartilage; and the inner surface rests on the vocal cords, and on the ventricle and pouch of the larynx.

use.

Action. The thyro-arytenoid draws forwards the arytenoid cartilage, and causes the cricoid to move forwards and downwards, thus opposing the crico-thyroid muscle, and slackening the vocal cords. It also moves inwards the fore part of the arytenoid cartilage with the true vocal cord, so as to place the latter in the position necessary for vocalisation. The short fibres passing from the arytenoid cartilage to the vocal cord will tighten the fore part, and relax the hinder part of the cord.

Thyro-epiglottidean muscle;

The THYRO-EPIGLOTTIDEAN MUSCLE is a thin layer which varies much in its development in different bodies. Its fibres *arise* from the thyroid cartilage in conjunction with the outer part of the thyro-arytenoid, and are directed upwards, covering the outer surface of the saccule of the larynx, to be *inserted* into the margin of the epiglottis and the aryteno-epiglottidean fold with the aryteno-epiglottidean muscle. The whole of the muscular fibres passing from the arytenoid and thyroid cartilages to the epiglottis are sometimes described together as the *depressor of the epiglottis.*

Action. This muscle draws downwards the epiglottis and aryteno-epiglottidean fold, and assists in closing the upper aperture of the larynx. use.

CAVITY OF THE LARYNX AND PARTS INSIDE. On looking into the cavity of the larynx from above, the tube will be seen to become narrower from above downwards, owing to the projection inwards of two prominent folds on each side termed the *vocal cords*. The lower or true vocal cords are placed on a level with the bases of the arytenoid cartilages, and the slit-like interval between them is called the *glottis*. Below this the cavity enlarges again to the *lower aperture of the larynx*, where it is continued into the trachea. Interior of larynx. The cavity is constricted in middle.

Upper aperture of the larynx (fig. 233, N, p. 659). This is the orifice by which the larynx communicates with the pharynx. It is triangular in shape, with the base, which is formed by the epiglottis, turned forwards and upwards. The sides, which are sloped from before downwards and backwards, are formed by the aryteno-epiglottidean folds of the mucous membrane; and at the apex is the arytenoid muscle, with the upper ends of the arytenoid cartilages, covered by the mucous membrane. This aperture is closed by the tubercle of the epiglottis during deglutition. Upper opening: form and boundaries.

The *lower aperture of the larynx*, bounded by the lower edge of the cricoid cartilage, is nearly circular in form, and of the same size as the interior of the cartilage. Lower opening.

Dissection. To see the parts within the larynx, the tube is to be divided by a median incision along the back; but in cutting through the arytenoid muscle, let the knife be carried a little to the right of the middle line, so as to avoid the nerves entering it. Dissection.

On the side wall of the larynx (fig. 247, p. 695) there will now be seen the projecting bands of the vocal cords separated by a depression called the *ventricle of the larynx* (A). If a probe be passed into this hollow, it will enter a small pouch—*sacculus laryngis* (D), by an aperture at the upper and fore part, under cover of the superior vocal cord. Parts inside larynx.

The *glottis* or *rima glottidis* is the narrowest part of the laryngeal cavity, and is placed on a level with the bases of the arytenoid cartilages. If the cut surfaces of the back of the larynx be placed together, it will be seen to have the form of an elongated triangle, with the base turned backwards. It is bounded on the sides by the true vocal cords (B) in the anterior two-thirds of its extent, and by the arytenoid cartilages (E) in the posterior third. In front, the right and left vocal cords meet at their attachment to the thyroid cartilage; and behind, the base is formed by the arytenoid muscle. The portion of the slit between the vocal cords, being alone concerned in the production of the voice, is distinguished as the *vocal glottis*, while the part between the arytenoid cartilages is termed the *respiratory glottis*. Glottis: position, forms and boundaries; subdivision.

The size of the glottis differs in the two sexes; and its form undergoes frequent changes during life, caused by the movements of the arytenoid cartilages and the vocal cords. *In the male*, the Size and form vary: length,

and breadth. interval measures nearly an inch from before backwards; *in the female*, nearly a quarter of an inch less. Its breadth at the base is about one-third of the length. The length of the glottis is increased by the stretching, and shortened by the relaxation of the vocal cords.

Form during life; in easy respiration; in forced inspiration; in production of the voice. *In quiet breathing* the glottis has the triangular form seen after death, the space being slightly widened in inspiration, and narrowed in expiration. *In forcible inspiration* it becomes widely dilated, the vocal processes of the arytenoid cartilages being directed outwards, and the aperture acquiring the form of a lozenge with the posterior angle truncated. The widest part is then opposite the junction of the vocal cords with the arytenoid cartilages, and its transverse measurement is about one half of the length. *During vocalisation* the cords and the vocal processes of the arytenoid cartilages are brought together, and the vocal glottis is reduced to a narrow chink, while the hinder part of the space is closed by the meeting of the anterior borders of the arytenoid cartilages.

Muscles producing changes in glottis. The glottis is rendered longer, and the vocal cords are tightened by the crico-thyroid muscles; the opposite effect is produced by the elasticity of the cords and the contraction of the thyro-arytenoid muscles. Widening of the glottis is effected by the posterior crico-arytenoid muscles; and the cords and arytenoid cartilages are approximated by the thyro-arytenoid, lateral crico-arytenoid, and arytenoid muscles.

Ventricle: situation. The *ventricle* of the larynx (fig. 247, A) is best seen on the left side. It is the boat-shaped hollow between the vocal cords, the upper margin being concave, and the lower nearly straight. It is lined by the mucous membrane, and on the outer surface are the fibres of the thyro-arytenoid muscle. In its roof, towards the front, is the aperture of the laryngeal pouch.

Pouch of larynx: form and position; surrounding parts. The *laryngeal pouch* or *sacculus laryngis* (fig. 247, D), has been laid bare partly on the right side by the removal of the ala of the thyroid cartilage, but it will be opened in the subsequent dissection for the vocal cords.

It is a small membranous sac, about half an inch long and rather conical in form, which projects upwards between the false vocal cord and the ala of the thyroid cartilage, reaching as high as the upper border of the latter. Its cavity communicates with the fore part of the ventricle by a somewhat narrow aperture. On the deep surface of the mucous lining are numerous small glands, the ducts of which open on the inside. Its outer side is covered by the thyro-epiglottidean muscle. The size and extent of the pouch vary greatly in different subjects.

Dissection of vocal cords. **Dissection.** The general shape and position of the vocal cords are evident on the left half of the larynx, but to show more fully the nature of the lower cord, put the cut surfaces in contact, and detach on the right side the lateral crico-arytenoid muscle from its cartilages. Take away in like manner the thyro-arytenoid, raising it from before back. By the removal of the last muscle an elastic membrane, crico-

thyroid (fig. 249, [6], p. 702), comes into view; and it will be seen to be continued upwards into, and give rise to the prominence of the inferior or true vocal cord. Lastly, dissect off the mucous membrane from the vocal cords on the right side, and in doing this the wall of the ventricle and saccule, which are formed mainly by this membrane, will disappear.

and cricothyroid membrane.

The VOCAL CORDS (fig. 247) are two bands on each side, which extend from the angle of the thyroid to the arytenoid cartilage, one forming the upper, the other the lower margin of the ventricle of the larynx. Each consists of a fold of the mucous membrane supported by a ligamentous structure — the superior and inferior thyro-arytenoid ligaments respectively.

Vocal cords;

construction.

Superior cord,

and thyro-arytenoid ligament.

FIG. 247.—VOCAL APPARATUS, ON A VERTICAL SECTION OF THE LARYNX.

A. Ventricle of the larynx.
B. True vocal cord.
C. False vocal cord.
D. Sacculus laryngis.
E. Arytenoid cartilage.
F. Cricoid cartilage.
G. Thyroid cartilage.
H. Epiglottis.
K. Crico-thyroid membrane.
L. Thyro-hyoid membrane.

The *superior* or *false vocal cord* (C) is arched with its concavity downwards, and is much softer and looser than the lower. Its free border is thick and rounded. The contained *superior thyro-arytenoid ligament* consists mostly of white fibrous tissue, and is fixed in front to the angle of the thyroid cartilage near the attachment of the epiglottis, behind to the middle portion of the anterior surface of the arytenoid cartilage. It is continuous above with scattered fibrous bundles in the aryteno-epiglottidean fold.

The *inferior* or *true vocal cord* (B) is attached in front to the angle of the thyroid cartilage about half way down below the notch, and behind to the vocal process of the arytenoid cartilage. Between these points, its free margin, by the vibration of which the voice is produced, is straight, sharp and smooth. The cord projects upwards and inwards into the cavity of the larynx, and forms the boundary of the vocal portion of the glottis. It is about $\frac{7}{12}$ths of an inch long in the male, and $\frac{3}{12}$ths of an inch less in the female. The mucous

Inferior cord,

membrane of the true vocal cord is very thin, and intimately united to the *inferior thyro-arytenoid ligament*. The latter structure is the upper edge of the lateral portion of the crico-thyroid membrane, and consists of fine elastic tissue, which shows a slight thickening close to its attachment to the thyroid cartilage. On the outer surface of the ligament is the deep part of the thyro-arytenoid muscle, some of the fibres of which are inserted into the band ; and a thin submucous layer of elastic tissue is continued outwards from it to line the ventricle of the larynx.

and ligament.

Mucous membrane of larynx.

The MUCOUS MEMBRANE of the larynx is continued from that lining the pharynx, and is prolonged downwards into the trachea. At the superior aperture of the larynx it forms the aryteno-epiglottidean fold on each side, between the margin of the epiglottis and the tip of the arytenoid cartilage : here it is very loose, and the submucous tissue abundant. In the larynx the membrane lines the wall of the cavity closely, sinks into the ventricle, and sends a prolongation upwards into the laryngeal pouch. On the lower thyro-arytenoid ligaments it is very thin and closely adherent, allowing these to be visible through it.

Epithelium differs in kind.

In the small part of the larynx above the superior vocal cords, the epithelium is of the stratified squamous kind, and free from cilia. But a columnar ciliated epithelium covers the edges of the superior cords and the surface below these, though it becomes flattened without cilia on the lower cords ; on the epiglottis the epithelium is ciliated in the lower half.

Glands.

Numerous racemose *glands* are connected with the mucous membrane of the larynx ; and the orifices will be seen on the surface, especially at the posterior aspect of the epiglottis. In the edge of the aryteno-epiglottidean fold there is a little swelling occasioned by a mass of subjacent glands (arytenoid) ; and along the upper vocal cord lies another set. None exist over the true vocal cords, but close to those bands is the collection of the sacculus laryngis, which moistens the ventricle and the lower vocal cord.

Dissection of nerves ;

Dissection *of nerves and vessels.* The termination of the laryngeal nerves may be dissected on the left side of the larynx. For this purpose the half of the thyroid is to be disarticulated from the cricoid cartilage, care being taken of the recurrent nerve, which lies close behind the joint between the two. The trachea and larynx should be fastened down with pins ; and after the thyroid has been drawn away from the cricoid cartilage, the recurrent laryngeal nerve can be traced over the side of the latter cartilage to the muscles of the larynx and the mucous membrane of the pharynx.

inferior,

superior laryngeal ;

Afterwards the superior laryngeal nerve is found as it pierces the thyro-hyoid membrane, and branches of it are to be followed to the mucous membrane of the larynx and pharynx. Two communications are to be looked for between the laryngeal nerves ; one is beneath the thyroid cartilage, the other in the mucous membrane of the pharynx.

of vessels.

An artery accompanies each nerve, and its offsets are to be dissected at the same time as the nerve.

NERVES. The nerves of the larynx are the superior and inferior laryngeal branches of the pneumo-gastric : the former is distributed to the mucous membrane, and the latter mostly to the muscles. Nerves are from vagus.

The *inferior laryngeal nerve* (recurrent), when about to enter the larynx, furnishes backwards an offset to the mucous membrane of the pharynx; this joins filaments of the upper laryngeal. The nerve passes finally beneath the ala of the thyroid cartilage, and ends in branches for all the special muscles of the larynx, except the crico-thyroid. Its small muscular branches are mostly superficial, but that to the arytenoid muscle lies beneath the posterior crico-arytenoid. Beneath the thyroid cartilage the inferior is joined by a long offset of the upper laryngeal nerve. Recurrent nerve — supplies intrinsic muscles except one.

The *superior laryngeal nerve* (internal division) pierces the thyro-hyoid membrane, and gives offsets to the mucous membrane of the pharynx ; it furnishes also a long branch beneath the ala of the thyroid cartilage to communicate with the recurrent nerve. The trunk terminates in many branches for the supply of the mucous membrane :—Some of these ascend in the aryteno-epiglottidean fold to the epiglottis, and the root of the tongue. The others, which are the largest, descend on the inner side of the sacculus, and supply the lining membrane of the larynx as low as the true vocal cords. One branch of this set pierces the arytenoid muscle, and ends in the mucous membrane. Superior laryngeal nerve — joins recurrent, — and ends in mucous membrane.

The external branch of the superior laryngeal nerve has previously been traced to the crico-thyroid muscle (p. 634). External laryngeal nerve.

VESSELS. The arteries of the larynx are furnished from the superior and inferior thyroid branches. Arteries :

The *laryngeal branch* of the *superior thyroid artery* enters the larynx with the superior laryngeal nerve, and divides into ascending and descending branches ; some of these enter the muscles, but the rest supply the epiglottis, and the mucous membrane from the root of the tongue to the vocal cord. Like the nerves, the two laryngeal arteries communicate beneath the ala of the thyroid cartilage, and in the mucous membrane of the pharynx. superior laryngeal from superior thyroid ;

The *laryngeal branch* of the *inferior thyroid artery* ascends on the back of the cricoid cartilage, and ends in the mucous membrane of the pharynx and the posterior muscles of the larynx. inferior laryngeal from inferior thyroid ;

Some other twigs from the *crico-thyroid branch* of the *superior thyroid artery* perforate the crico-thyroid membrane, and ramify in the mucous lining of the interior of the larynx at the lower part. from crico-thyroid artery.

Laryngeal veins. The vein accompanying the branch of the superior thyroid artery joins the internal jugular or the superior thyroid vein, and the vein with the artery from the inferior thyroid opens into the plexus of the inferior thyroid veins. Veins.

The *lymphatics* of the larynx pass to the deep cervical glands. Lymphatics.

Section XVI.

THE HYOID BONE, THE CARTILAGES AND LIGAMENTS OF THE LARYNX, AND THE STRUCTURE OF THE TRACHEA.

Dissection.

Dissection. A fresh larynx should be obtained for this Section if possible. Failing that good use may be made of the parts remaining in the specimen already examined. All the muscles and the mucous membrane are to be taken away so as to denude the hyoid bone, the cartilages of the larynx, and the epiglottis; but the membrane joining the hyoid bone to the thyroid cartilage, and the ligaments uniting one cartilage to another on the left side, should not be destroyed.

In the aryteno-epiglottidean fold of mucous membrane, a small cartilaginous body (cuneiform) may be recognised; an oblique whitish projection indicates its position.

Hyoid bone: form;

The HYOID BONE (fig. 248) is situate between the larynx and the root of the tongue. Resembling the letter U placed horizontally, and with the legs turned backwards, it offers for examination a central part or body, and two lateral pieces or cornua on each side.

body;

The *body* (G) is elongated transversely, in which direction it measures about an inch, and flattened from before backwards. The anterior surface is convex, and marked in the centre by a tubercle, on each side of which is an impression for muscular attachment. The posterior surface is concave and smooth. To the upper border the hyo-glossal membrane, fixing the tongue, is attached.

cornua, large

The cornua are two in number on each side—large and small. The *large cornu* (H) continues the bone backwards, and is joined to the body by an intervening piece of cartilage, or in old persons by continuous bony union. The surfaces of this cornu look rather upwards and downwards; and the size decreases from before backwards. It ends posteriorly in a tubercle. The *small cornu* (J) is directed upwards from the point of union of the great cornu with the body, and is joined by the stylo-hyoid ligament; it is seldom wholly ossified. It is united to the body of the bone by a synovial joint, with a surrounding capsule.

and small.

In larynx there are four large

CARTILAGES OF THE LARYNX (fig. 248). There are four large cartilages in the larynx, by which the vocal cords are supported, viz., the thyroid, the cricoid, and the two arytenoid. In addition there are some yellow fibro-cartilaginous structures, viz., the epiglottis, a capitulum to each arytenoid cartilage, and a small ovalish piece (cuneiform) in each aryteno-epiglottidean fold of mucous membrane.

and some small cartilages.

Thyroid cartilage

The THYROID CARTILAGE (B) is the largest of all: it forms the front of the larynx, and protects the vocal apparatus as with a shield. The upper part of the cartilage is considerably wider than

the lower, and in consequence of this form the larynx is somewhat funnel-shaped. The fore part is prominent in the middle line in front, forming the subcutaneous swelling named the *pomum Adami*, and concave behind, where it gives attachment to the epiglottis, and to the thyro-arytenoid muscles and ligaments. The upper border is notched in the centre.

is convex in front, concave behind:

The cartilage consists of two squarish halves or *alæ*, which are united in front. Posteriorly each ala has a thick border, which is continued upwards and downwards into a rounded process or *cornu* (E and F). Both cornua are bent slightly inwards: of the two, the upper (E) is the longer; but the lower one (F) is the thicker, and articulates with cricoid cartilage. The inner surface of the ala is smooth; the outer is marked by an oblique line for the attachment of muscles, which extends from a tubercle near the root of the upper cornu, to a projection at the middle of the lower border.

formed of two alæ, each having upper and lower cornua.

Cricoid cartilage:

The CRICOID CARTILAGE (D) is stronger though smaller than the thyroid, and surrounds the lower part of the cavity of the larynx; it is partly concealed by the thyroid cartilage, below which it is placed. It is something like a signet ring, being very unequal in depth before and behind,—the posterior part being nearly four times as deep as the anterior. Its contained space is about as large as the forefinger.

form;

FIG. 248.—HYOID BONE AND LARYNGEAL CARTILAGES.

A. Epiglottis.
B. Thyroid cartilage.
C.C. Arytenoid cartilages.
D. Cricoid cartilage.
E. Upper cornu.
F. Lower cornu of thyroid cartilage.
G. Body of hyoid bone.
H. Large cornu.
J. Small cornu.

surfaces;

At the back of the cartilage there is a flat and rather square portion, which is marked on its posterior surface by a median ridge between two oval depressions which are occupied by the posterior crico-arytenoid muscles. On each side, immediately in front of the square part, is a slightly raised articular facet, which receives the lower cornu of the thyroid cartilage. The inner surface is smooth, and is covered by mucous membrane.

The lower border is horizontal, somewhat undulating, and is united to the trachea by fibrous membrane. The upper border of

is borders.

the broad part of the cartilage is slightly excavated in the middle, and is limited on each side by a convex articular facet for the arytenoid cartilage, which slopes downwards and outwards. In front of that spot, the border descends rapidly as it passes forwards to the middle line.

Arytenoid cartilages: situation and form; The two ARYTENOID CARTILAGES (c) are placed one on each side at the back of the larynx, on the upper border of the cricoid cartilage. Each is pyramidal in shape, is about half an inch in depth, and offers for examination a base and apex, and three surfaces.

base; The base has the form of an elongated triangle, with one of the angles (the postero-internal) rounded off. Its anterior extremity is thin and tapering, and gives attachment to the inferior thyro-arytenoid ligament, whence it is named the *vocal process*. The external angle is thick, and projects backwards and outwards, forming the *muscular process*, into which the crico-arytenoid muscles are inserted. On the under aspect of the muscular process is an oval, concave articular facet, sloped downwards and outwards, for the cricoid cartilage. The apex of the cartilage is directed backwards, and is surmounted by the cartilage of Santorini.

apex;

surfaces, internal, anterior or external, and posterior. The inner surface is narrow, especially above, and flat; and it is covered by the mucous membrane. The anterior or outer surface is the largest and irregular, being convex above and concave below. It is marked near the upper end by a tubercle, and lower down, at the junction of the middle and lower thirds, by an oblique ridge. This surface gives attachment to the superior thyro-arytenoid ligament and the thyro-arytenoid muscle. At its posterior aspect the cartilage is concave and smooth, being covered by the arytenoid muscle.

Fibro-cartilages of Santorini. CARTILAGES OF SANTORINI, *cornicula* or *capitula laryngis*. Attached to the apex of each arytenoid cartilage is the small, conical fibro-cartilage of Santorini, which is inclined backwards and inwards. The aryteno-epiglottidean fold is connected with it.

Fibro-cartilages of Wrisberg. CUNEIFORM CARTILAGES. Two other small fibro-cartilaginous bodies, one on each side, which are contained in the aryteno-epiglottidean folds, have received this name. Each is somewhat elongated in form, like a grain of rice; it is situate obliquely in front of the capitulum of the arytenoid cartilage, and its place in the fold of the mucous membrane is marked by a slight whitish projection. These cartilages are often absent.

Epiglottis: form and position; The EPIGLOTTIS (fig. 248, A) is single, and is the largest of the pieces of yellow fibro-cartilage. In form it resembles an ovate leaf, with the stalk below and the blade above. Its position is behind the tongue and in front of the orifice of the larynx. During respiration it is placed vertically; but during deglutition it takes an oblique direction over the opening of the larynx.

surfaces, anterior, The anterior surface is covered in its upper part by mucous membrane, which forms the three glosso-epiglottidean folds (p. 687) between it and the tongue; its lower part is attached to the hyoid bone by fatty tissue containing glands, and by the hyo-epiglottidean

ligament. The posterior surface is entirely covered by closely adherent mucous membrane, and is for the most part concave; but at the lower end there is an elevation known as the *tubercle* or *cushion of the epiglottis*. To the sides the aryteno-epiglottidean folds of mucous membrane are united. After the mucous membrane has been removed from the cartilage, its substance will be seen to be excavated by numerous pits, which lodge mucous glands.

and posterior; sides; glands in it.

In the adult the hyaline cartilages of the larynx are commonly to a greater or less extent (in old persons sometimes completely) converted into bone. The ossification begins in the thyroid and cricoid cartilages at about twenty years of age, the deposition of osseous matter in the former taking place first in the neighbourhood of the inferior cornu, and thence extending along the inferior and posterior borders; while in the cricoid two or three bony spots appear near the arytenoid articular surface on each side, and spread through the upper part of the cartilage. The arytenoid cartilages ossify later, from below upwards. The tendency to ossification is more marked in the male than in the female.

Ossification of laryngeal cartilages.

LIGAMENTS OF THE LARYNX. The larynx is connected by extrinsic ligaments with the hyoid bone above and the trachea below. Other ligaments unite together the cartilages, sometimes with joints.

Ligaments of the larynx.

Union of the larynx with the hyoid bone and the trachea. A loose elastic membrane (thyro-hyoid) extends from the thyroid cartilage to the hyoid bone; and a second membrane connects the cricoid cartilage with the trachea.

To hyoid bone and trachea.

The *thyro-hyoid membrane* (fig. 247, L, p. 695) is attached on the one hand to the upper border of the thyroid cartilage; and on the other to the upper border of the hyoid bone. Its central part, extending from the body of the hyoid bone to the margins of the notch in the thyroid cartilage, is of some thickness, but its lateral parts are thin and ill-defined. It ends behind in a rounded elastic cord on each side (lateral thyro-hyoid ligament), uniting the extremity of the great cornu of the hyoid bone to the superior cornu of the thyroid cartilage: this band frequently contains a small cartilaginous or osseous nodule (cartilago triticea).

Thyro-hyoid membrane: median and lateral parts. Lateral thyro-hyoid ligament often contains a cartilage.

The superior laryngeal nerve and vessels perforate the lateral part of the membrane: and a synovial bursa is placed between its central part and the posterior surface of the body of the hyoid bone.

Relations.

The membrane joining the lower border of the cricoid cartilage to the first ring of the trachea, *crico-tracheal ligament*, resembles the fibrous layer joining the rings of the trachea to the other.

Crico-tracheal membrane.

Union of the cricoid and thyroid cartilages. These cartilages are united by a membrane in front, and a synovial joint on each side.

The *crico-thyroid membrane* (fig. 249, [6]) occupies the space between the thyroid, cricoid, and arytenoid cartilages; and its right half is now visible. It is of a yellow colour and is formed mainly of elastic tissue. By its lower border the membrane is fixed to the upper edge of the cricoid cartilage, reaching back to the articulation with the arytenoid. Its central part is thick and strong, and is attached

Crico-thyroid membrane: median part,

and lateral parts; above to the lower border of the thyroid cartilage (see fig. 212, p. 587). The lateral part is thinner, and is continued upwards beneath the ala of the thyroid cartilage, to end in a thickened border, which is attached behind to the vocal process of the arytenoid cartilage, constituting the inferior thyro-arytenoid ligament in the true vocal cord.

relations. The central part of the membrane is partly exposed between the crico-thyroid muscles, and small apertures exist in it for the passage of vessels into the larynx. The lateral part is separated from thyroid cartilage by the thyro-arytenoid and lateral crico-arytenoid muscles. The deep surface of the membrane is lined by the mucous membrane.

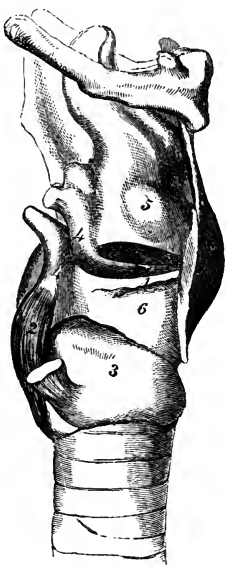


FIG. 249.—VIEW OF THE VOCAL CORDS AND CRICO-THYROID LIGAMENTS.

1. True vocal cord.
2. Posterior crico-arytenoid muscle.
3. Cricoid cartilage.
4. Arytenoid cartilage.
5. Sacculus laryngis.
6. Lateral part of the crico-thyroid membrane.

Crico-thyroid joint: The *crico-thyroid articulation* is formed between the inferior cornu of the thyroid and the lateral articular facet of the cricoid cartilage. A *capsular ligament*, which is thickest behind, and lined by synovial membrane, surrounds the articulation.

movements. This joint allows of a slight degree of gliding movement backwards and forwards, and of a rotatory movement around a transverse axis, by which the front of the cricoid cartilage is raised or depressed.

Crico-arytenoid joint and ligament: *Crico-arytenoid articulation.* Between the cricoid and arytenoid cartilages there is a synovial joint surrounded by a loose capsule. To the inner side of the joint there is a well marked *crico-arytenoid ligament*, which passes from the upper border of the cricoid cartilage near the middle line to the adjacent part of the base of the arytenoid and prevents the latter cartilage being drawn forwards over the cricoid.

movements, gliding and rotation. The arytenoid cartilage glides upwards and inwards, or downwards and outwards, to a slight extent on the oblique articular facet of the cricoid; but its principal movement is one of rotation, by which the vocal process is carried inwards and somewhat downwards, approximating the vocal cords and narrowing the glottis, or outwards and upwards, enlarging the glottis.

Arytenoid and capitulum. Between the apex of the arytenoid cartilage and the capitulum there is sometimes a synovial joint, but the two cartilages are most frequently united by connective or fibro-cartilaginous tissue.

The *thyro-arytenoid ligaments* have been examined with the vocal cords (pp. 695 and 696).

Ligaments of the epiglottis. An elastic band, *thyro-epiglottidean ligament,* connects the lower extremity of the epiglottis to the thyroid cartilage, close to the notch in the upper border of the latter (fig. 247); and a membranous layer of fibrous and elastic tissue, *hyo-epiglottidean ligament,* passes between the front of the epiglottis and the hyoid bone. Two ligaments of epiglottis.

STRUCTURE OF THE TRACHEA. The windpipe consists of a series of pieces of cartilage, which are deficient behind, and connected together by fibrous tissue. The interval between the cartilages at the back of the tube is closed by fibrous membrane and muscular fibres; and the interior is lined by mucous membrane with subjacent elastic tissue. Constituents of trachea.

Cartilages. The pieces of cartilages vary in number from sixteen to twenty. Each forms about three-fourths of a ring, extending round the front and sides of the airtube. Their arrangement is not quite regular throughout, for some of them are often bifurcated at one end, or sometimes two adjacent pieces are partly fused together. The highest is commonly broader than the others, and may be joined to the cricoid cartilage. The lowest piece is triradiate, or V-shaped, a median process being sent downwards and backwards in the angle between the two bronchi. Cartilages: form; irregularities.

The *fibrous membrane* ensheaths the cartilages, and, being continued across the intervening spaces, binds them together. It also extends across the posterior part of the trachea. Fibrous layer.

Dissection. On removing the fibrous membrane and the mucous glands from the interval between the cartilages at the back of the trachea, the muscular fibres will appear. Dissection.

After the muscular fibres have been examined the membranous part of the tube may be divided, to see the elastic tissue and the mucous membrane.

Muscular fibres. Between the ends of the cartilages is a continuous layer of transverse bundles of unstriated muscle, which is attached to the truncated ends and the adjacent part of the inner surface of the cartilaginous hoops. By the one surface the fleshy fibres are in contact with the fibrous membrane and glands, and by the other with the elastic tissue. Some longitudinal fibres are superficial to the transverse; they are arranged in scattered bundles, and are attached to the fibrous tissue. Muscular layer at back.

The *elastic tissue* forms a complete lining to the trachea beneath the mucous membrane; and at the posterior part, where the cartilages are wanting, it is gathered into strong longitudinal bundles. This layer is closely connected with the mucous membrane covering it. Submucous elastic tissue.

The *mucous membrane* of the trachea lines the tube, and is furnished with a columnar ciliated epithelium. Mucous membrane, epithelium and glands.

Connected with this membrane are numerous branched *mucous glands* of variable size. The largest are found at the back of the trachea, in the membranous part of the wall, where some are placed outside the fibrous layer, and others between that membrane and

the muscular fibres. Smaller glands lie beneath the mucous membrane.

Other small glands are found at the front and sides of the trachea, being situate on and in the fibrous tissue connecting the cartilaginous rings.

Vessels and nerves.

The *arteries* of the trachea are derived from the inferior thyroid and bronchial. The *veins* have a corresponding disposition. *Nerves* are supplied to the tube from the vagus, mainly through the recurrent laryngeal, and from the sympathetic.

Section XVII.

PREVERTEBRAL MUSCLES AND VERTEBRAL VESSELS.

Muscles in front of spine.

Directions. On the piece of the spinal column which was laid aside after the separation of the pharynx the student is to learn the deep muscles on the front of the vertebræ.

Dissection.

Dissection. The prevertebral muscles will be prepared by removing the fascia and areolar tissue. They are three in number on each side (fig. 250), and are easily distinguished. Nearest the middle line, and the longest, is the longus colli (A); the muscle external to it, which reaches to the head, is the rectus capitis anticus major (B); and the small muscle close to the skull, which is external to the last and partly concealed by it, is the rectus capitis anticus minor (G). The smaller rectus muscle is often injured in cutting through the basilar process of the occipital bone in separation of the pharynx.

The LONGUS COLLI MUSCLE (A) is situate on the bodies of the cervical and upper dorsal vertebræ, and is pointed above and below. It consists of *three parts*, one internal or *vertical* and two external or *oblique*, which differ in the direction of their fibres, but are closely united together. The *vertical part arises* by fleshy and tendinous processes from the bodies of the upper two dorsal and lower two cervical vertebræ, and from the front of the transverse processes of the lower three cervical vertebræ. It is *inserted* by similar slips into the bodies of the second, third, and fourth cervical vertebræ. The *upper oblique part* is inclined inwards. It *arises* from the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, and is *inserted* into the side of the tubercle on the anterior arch of the atlas. It is generally joined by a slip from the upper end of the vertical part of the muscle. The *lower oblique part*, passing in the opposite direction to the last, *arises* in common with the vertical part from the upper dorsal vertebræ, and is *inserted* into the transverse processes of the fifth and sixth cervical vertebræ.

Longus colli in three parts: vertical, superior oblique, and inferior oblique;

parts in contact with it;

In contact with the anterior surface of the longus colli are the pharynx and the œsophagus. The inner border is at some distance from the muscle of the opposite side below, but above only the

pointed anterior common ligament of the vertebræ separates the two. The outer border is contiguous to the anterior scalenus, to the vertebral vessels, and to the rectus capitis anticus major. The number and attachments of the slips of this muscle are subject to great variation.

Action. Both muscles bend forwards the neck; and the upper oblique part of one may rotate the head to the same side. use.

The RECTUS CAPITIS ANTICUS MAJOR (B) is external to the preceding muscle, and is largest at the upper end. Its *origin* is by pointed tendinous slips from the anterior tubercles of the transverse processes Rectus anticus major: origin;

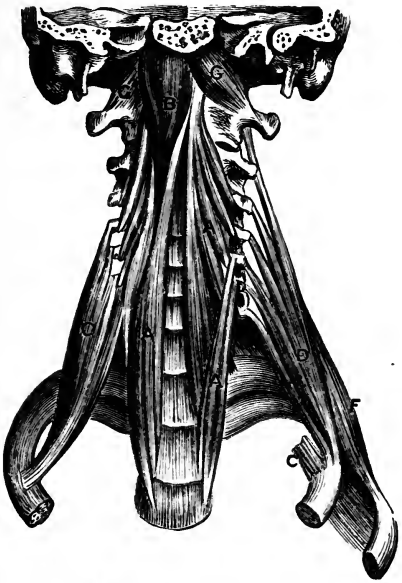


FIG. 250.—DEEP MUSCLES OF THE FRONT OF THE NECK, AND THE SCALENI.

A. Longus colli.
B. Rectus capitus anticus major.
C. Scalenus anticus.
D. Scalenus medius.
F. Scalenus posticus.
G. Rectus capitis anticus minor.

of the third, fourth, fifth, and sixth cervical vertebræ; and the fibres ascend to be *inserted* into the basilar process of the occipital bone by the side of the pharyngeal tubercle, reaching from the middle line to the petrous portion of the temporal bone. insertion;

This muscle partly conceals the longus colli and rectus anticus minor. Its anterior surface is in contact with the pharynx, the internal and common carotid arteries, and the sympathetic nerve. The origin from the cervical vertebræ corresponds with that of the scalenus anticus. relations;

Action. It flexes the head and the cervical portion of the spine. use.

Rectus anticus minor is beneath preceding:

The RECTUS CAPITIS ANTICUS MINOR (G) is a small flat muscle which *arises* from the front of the lateral mass of the atlas at the root of the transverse process, and is *inserted* into the basilar process of the occipital bone behind the last muscle, and half an inch from its fellow.

The anterior primary branch of the suboccipital nerve emerges between the borders of this muscle and the rectus capitis lateralis.

use.

Action. It helps in bending forwards the head.

Dissection of intertransversales.

Dissection. The small intertransverse muscles will come into view when the other muscles have been removed from the front and back of the transverse processes. By tracing towards the spine the anterior primary branches of the cervical nerves, the intertransversales will be readily seen in front of and behind them.

After the muscles and nerves have been examined, the tips of the transverse processes may be cut off to lay bare the vertebral artery.

Intertransverse muscles: number and attachments;

The INTERTRANSVERSE MUSCLES are slender fleshy slips in the intervals between the transverse processes. In the neck there are six pairs on each side—the first being between the atlas and axis. One set is attached to the anterior, and the other to the posterior tubercles of the transverse processes.

relations;

The anterior primary divisions of the corresponding spinal nerves issue between these muscles; and the posterior primary divisions lie to the inner side of the hinder muscles. Between the atlas and the occipital bone the rectus anticus minor and rectus lateralis represent intertransverse muscles.

use.

Action. By approximating the transverse processes these muscles bend the spinal column laterally.

Cervical nerves in their foramina give

CERVICAL NERVES AT THEIR EXIT FROM THE SPINAL CANAL. The trunks of the cervical nerves issue from the spinal canal through the intervertebral foramina, except the first two, and bifurcate into anterior and posterior primary branches.

anterior

The *anterior primary branch* passes outwards between the intertransverse muscles, and joins with its fellows in the plexuses already described.

and posterior branches.

The *posterior primary branch* turns to the back beneath the posterior intertransverse muscle and the other muscles attached to the posterior parts of the transverse processes; in its course it lies close to the bone between the articular processes of the vertebra.

First two nerves differ:

Peculiarities in the first two. The first two nerves leave the spinal canal above the neural arches of the atlas and axis, and divide at the back of the neck into anterior and posterior branches.

anterior and

The *anterior primary branch of the first or suboccipital nerve* has been examined (p. 636). The *anterior branch of the second nerve,* after perforating the membrane between the neural arches of the first and second vertebræ, is directed forwards outside the vertebral artery, and between the two intertransverse muscles of the first space, to join the cervical plexus.

posterior branches.

The *posterior primary branches* of the first two nerves are described in the dissection of the back.

The VERTEBRAL ARTERY has been seen at its origin in the lower part of the neck (p. 593); and its termination is described with the vessels of the brain. Entering, usually, the foramen in the sixth cervical vertebra the artery ascends through the corresponding foramina in the other vertebræ. Finally, the vessel winds backwards round the upper articular process and crosses the neural arch of the atlas, piercing the posterior occipito-atlantal ligament and the dura mater, to enter the skull through the foramen magnum. In its course upwards the artery lies in front of the anterior trunks of the cervical nerves, except the first, which crosses on the inner side. The vessel is accompanied by a vein, and by a plexus of nerves of the same name.

Vertebral artery in neck: course; relation to the nerves; a vein, and nerves are with it;

In the neck the artery furnishes small twigs to the surrounding muscles, the spinal canal, and the spinal cord.

branches.

The *vertebral vein* begins on the neural arch of the atlas by the union of a considerable offset from the intraspinal venous plexuses with other branches proceeding from a network between the muscles in the suboccipital region. It is also joined by the emissary vein leaving the skull through the posterior condylar foramen when that aperture is present. In the neck, the vein forms a plexus around the artery in the foramina of the transverse processes; and it terminates below by emptying itself into the innominate trunk.

Vertebral vein: origin; course; ending;

In this course it is joined by branches from the internal and external spinal veins; its other tributaries are noticed at p. 594.

branches.

The *vertebral plexus of nerves* is derived from the inferior cervical ganglion of the sympathetic. It surrounds the artery, and communicates with the spinal nerves which it crosses.

Vertebral plexus of nerves.

SECTION XVIII.

LIGAMENTS OF THE VERTEBRÆ AND CLAVICLE.

Directions. On the remaining part of the spine, the ligaments connecting the cervical vertebræ to each other and to the occipital bone are to be learnt.

Directions.

Dissection. Disarticulate the last cervical from the first dorsal vertebra. Then remove altogether the muscles, vessels, nerves, and areolar tissue and fat from the cervical vertebræ. By sawing through the occipital bone, so as to leave only an osseous ring behind the foramen magnum, the ligaments between the atlas and the occipital bone can be more easily cleaned.

Dissection.

The COMMON LIGAMENTS attaching together the cervical vertebræ are similar to those uniting the bones in other parts of the spine, viz., an anterior and a posterior common ligament, bands between the laminæ and spines, capsular ligaments lined by synovial membrane for the articular processes, and an intervertebral disc between the bodies of the bones.

Common ligaments vertebræ

are described elsewhere.

Directions. The common ligaments will be best seen on the dorsal or lumbar portion of the spine, where they are more strongly developed; their preparation and description will be found at the end of the thorax, with the description of the ligaments of the spine (pp. 492 to 498). Should the student examine them in the neck to see their difference in this region, he should leave uncut the neural arches of the upper two vertebræ, to which special ligaments are attached.

Special ligaments

SPECIAL LIGAMENTS unite the first two cervical vertebræ to each other and to the occipital bone: some of these are external to, and others within the spinal canal.

between first two vertebræ and occipital bone.

The *ligaments outside the spinal canal* are fibrous membranes, which connect the axis to the atlas, and the latter to the occipital

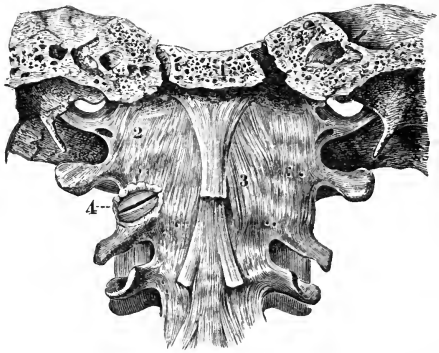


FIG. 251.—EXTERNAL LIGAMENTS IN FRONT BETWEEN THE OCCIPITAL BONE, ATLAS, AND AXIS. (Bourgery.)

1. Sawn basilar process.
2. Capsule of articulation between occipital bone and atlas, internal to which is the anterior occipito-atlantal ligament.
3. Anterior atlanto-axial.
4. Lateral articulation between the atlas and axis opened.

bone in front and behind. Capsular ligaments also surround the articulations formed by these bones on each side, but they will be examined more conveniently after the spinal canal has been opened.

Anterior ligament between atlas and axis,

The *anterior atlanto-axial ligament* (fig. 251, 3) consists of a membranous layer attached to the anterior arch of the atlas and the body of the axis, and a superficial thickened band in the centre, prolonged from the upper end of the anterior common ligament, and connecting the ridge on the front of the axis to the tubercle on the anterior arch of the altas.

and between atlas and occipital bone.

The *anterior occipito-atlantal ligament* (fig. 251, 2) resembles the foregoing, and passes from the basilar process of the occipital bone, immediately in front of the foramen magnum, to the anterior arch of the atlas. Its central part is also thickened, and is fixed to the tubercle on the front of the atlas.

The *posterior occipito-atlantal ligament* (fig. 252, [1]) is a thin broad membrane, the deep surface of which is intimately united to the

Posterior ligament between occipital bone and atlas,

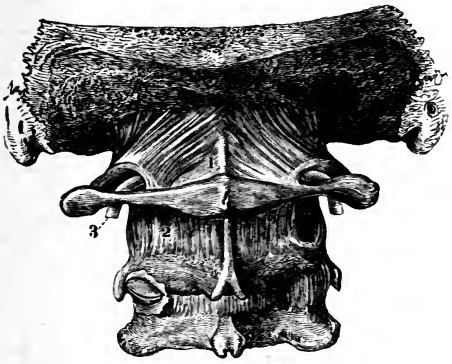


FIG. 252.—EXTERNAL LIGAMENTS BEHIND BETWEEN THE OCCIPITAL BONE, ATLAS, AND AXIS.

1. Posterior occipito-atlantal ligament.
2. Posterior atlanto-axial.
3. Vertebral artery entering beneath the occipito-atlantal ligament.

dura mater. It is attached above to the hinder margin of the foramen magnum of the occipital bone, and below to the posterior arch of the atlas. Behind the upper articular process of the altas

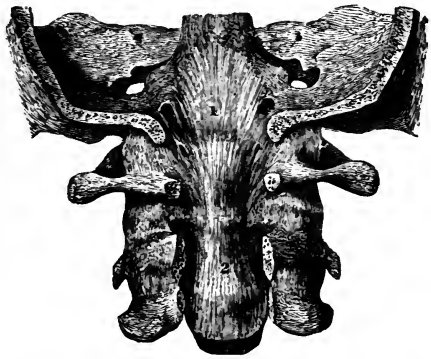


FIG. 253.—INTERNAL LIGAMENTS BETWEEN THE OCCIPITAL BONE, ATLAS, AND AXIS. First view. (Bourgery.)

1. Long occipito-axial ligament.
2. Beginning of the posterior common ligament.

it forms an arch over the groove of the bone in this situation, bounding with the latter an aperture through which the vertebral artery and the suboccipital nerve pass.

and between atlas and axis.

The *posterior atlanto-axial ligament* (2) is also thin, and adherent to the dura mater. It closes the interval between the neural arches of the atlas and axis, and is pierced on each side by the second cervical nerve.

Internal ligaments between same bones.

The *ligaments inside the spinal canal* are much stronger, and assist in retaining the skull in place during the rotatory and nodding movements of the head. Between the occipital bone and the second vertebra are four ligaments—a long occipito-axial with a central and two lateral odontoid; and the odontoid process of the axis is fixed against the body of the atlas by a transverse band.

Dissection of the ligaments.

Dissection (fig. 253). Supposing the neural arches of the cervical vertebræ to be removed except in the first two, the arches of these vertebræ are to be sawn through close to the articular processes. Next, the ring of the occipital bone bounding posteriorly the

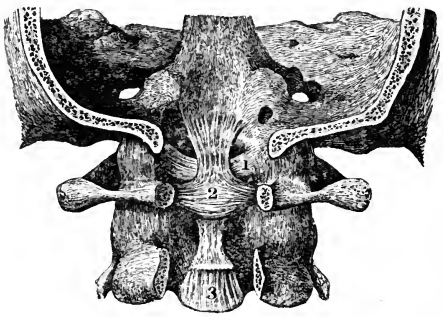


FIG. 254.—INTERNAL LIGAMENTS BETWEEN THE OCCIPITAL BONE, ATLAS, AND AXIS. Second view. (Bourgery.)

1. Check ligament.
2. Transverse ligament, sending offsets upwards and downwards.
3. Cut end of long occipito-axial ligament.

foramen magnum is to be taken away. Lastly, the student should detach the tube of dura mater from the interior of the spinal canal; and, by following upwards the posterior common ligament of the bodies of the vertebræ, its continuation, the long occipito-axial ligament will be exposed.

Long occipito-axial ligament.

The *long* or *posterior occipito-axial ligament* (fig. 253) is a strong flat band which continues upwards the posterior common ligament of the vertebræ. It is broad above, where it is attached to the upper surface of the basilar process of the occipital bone, reaching outwards on each side as far as the insertion of the check ligaments. Descending thence through the foramen magnum, and over the odontoid process, it becomes somewhat narrower, and is inserted mainly into the back of the body of the axis, but many of the superficial fibres are prolonged into the posterior common ligament. Occasionally a bursa is found between it and the transverse ligament.

Dissection (fig. 254). After the removal of the long occipito-axial ligament, by cutting through it transversely above, and reflecting it downwards, the student should define a strong band, the transverse ligament, which crosses the neck of the odontoid process, and sends upwards and downwards a slip to the occipital bone, and the axis. The upper offset from the transverse ligament may be cut through afterwards for the purpose of seeing the odontoid ligaments, which radiate from the process, the central one being a slender band in the middle line, and the lateral, much stronger, passing nearly horizontally outwards.

Dissection of transverse and odontoid ligaments.

The *transverse ligament of the atlas* (fig. 254, [2] and fig. 255, [1]) is a strong arched band behind the odontoid process, which is attached on each side to a tubercle on the inner surface of the lateral mass of the atlas, below the fore part of the upper articular process. The ligament is rounded at each end, but flattened and wider in the middle; and at this spot it has a band of longitudinal fibres connected with its upper and lower margins (fig. 254, [2]) so as to produce

To fix odontoid process is the transverse ligament, also named cruciform.

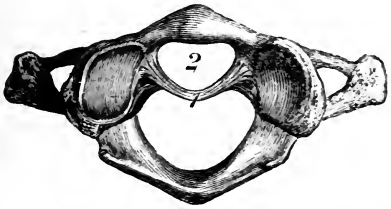


Fig. 255.—Atlas with the Transverse Ligament.

1. Transverse ligament with its offsets cut.
2. Space occupied by the odontoid process.

a cruciform figure: the upper band is inserted into the basi-occipital, and the lower into the body of the axis. Towards the spinal canal it is concealed by the long occipito-axial ligament.

This ligament forms, with the anterior arch of the atlas, a ring (fig. 255, [2]) which surrounds the neck of the odontoid process of the axis, and prevents separation of the bones.

Socket for odontoid process.

The *lateral odontoid* or *check ligaments* (fig. 254, [1]) are two strong bundles of fibres, attached by one end to a flat impression on each side of the head of the odontoid process, and by the other to a rough mark on the inner surface of the condyle of the occipital bone. These ligaments are covered by the long occipito-axial band: their upper fibres are short and nearly horizontal; the lower are longer and oblique.

Check ligaments.

The *central odontoid ligament* is a small median cord, which passes from the tip of the odontoid process to the anterior margin of the foramen magnum.

Suspensory ligament.

When the transverse and odontoid ligaments have been cut through, the odontoid process will be seen to have two cartilage-

Articular surfaces of odontoid

process, and two synovial sacs.

covered surfaces, which correspond to as many synovial sacs. One surface is on the front of the process, and articulates with the anterior arch of the atlas; the other is the floor of the groove behind the neck of the process, and is in contact with the transverse ligament. The posterior synovial sac is larger than the anterior.

Occipito-atlantal articulations are condyloid joints: articular surfaces.

OCCIPITO-ATLANTAL ARTICULATIONS. A synovial joint is formed between the condyle of the occipital bone and the upper articular process of the atlas on each side. Surrounding the articulation is a *capsular ligament* of scattered fibres, which is strongest externally and in front. When the joint is opened, the elliptical articular surface of the condyle will be seen to be convex in all directions, and to look outwards as well as downwards. The articular cavity of the atlas has a corresponding direction, upwards and inwards, and is marked by a slight transverse groove, from which the cartilage is often wanting.

Between atlas and axis are a pivot-joint and two gliding joints:

ATLANTO-AXIAL ARTICULATIONS. Three synovial joints exist between the atlas and axis. The *central articulation* is between the anterior arch of the atlas and the odontoid process, and has already been exposed. The *lateral articulations* are formed on each side by the inferior articular process of the atlas and the upper articular surface of the axis. These are united by a loose *capsule* (fig. 251, [4], p. 708), which is thickened so as to give rise to an *accessory ligament* at the inner and posterior aspect of the joint. The articular surface of the axis is somewhat convex, and is sloped downwards and outwards; while that of the atlas presents a slight transverse ridge in the middle, so that the opposed surfaces are more extensively in contact when the atlas is turned to one side, than when it is placed symmetrically over the axis.

articular surfaces of latter.

Movements of head, kinds of.

MOVEMENTS OF THE HEAD. The head can be bent forwards—flexion, or backwards—extension; it can be inclined towards the shoulder—lateral flexion; and it can be turned to either side—rotation.

Nodding movement: seat, extent, and checks.

Flexion and *extension* take place in the joints between the atlas and occipital bone; and the range of movement is greater in the forward than in the backward direction. Flexion is limited mainly by the long occipito-axial and the check ligaments; extension by the anterior occipito-atlantal ligament, and by the approximation of the occipital bone to the neural arch of the atlas. When the head is moved more freely, flexion and extension of the cervical portion of the spine come into play.

Inclination to side takes place in neck.

Lateral flexion is effected mainly by movement between the cervical vertebræ; but a very slight degree may be due to movement having its seat in the occipito-atlantal articulations.

Turning movement between atlas and axis; and in neck.

Rotation takes place in the atlanto-axial articulations, the atlas and head moving together round the pivot formed by the odontoid process. The movement is stopped by the check ligaments. Less than half of the whole possible rotation of the head is obtained between the atlas and axis, the rest being made up in the neck.

Sterno-clavicular articulation

STERNO-CLAVICULAR ARTICULATION (fig. 256). The articular surfaces of the two bones are not precisely adapted to each other,

and an interarticular fibro-cartilage is placed between them. They are united by a capsular ligament; and the clavicle receives additional support from a ligament passing to the first rib-cartilage, and from another band connecting it to the bone of the opposite side. is a compound joint.

Dissection. For the examination of the ligaments of the sterno-clavicular articulation, take the piece of the bones that have been set aside. If the ligaments have become dry, they may be moistened for a short time. The several ligaments will be seen in the situation indicated by their names, after the removal of some connective tissue. Dissection.

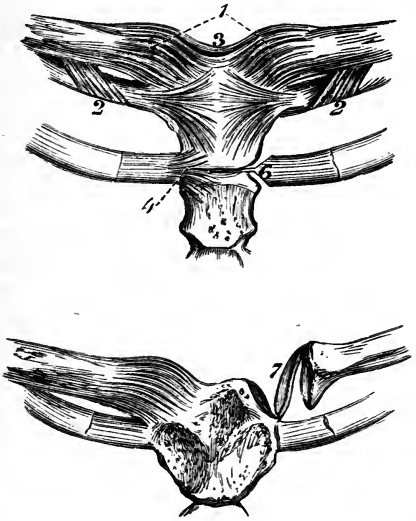


FIG. 256.—LIGAMENTS OF THE INNER END OF THE CLAVICLE, AND OF THE CARTILAGE OF THE SECOND RIB.

1. Capsule.
2. Costo-clavicular ligament.
3. Interclavicular ligament.
4. Anterior ligament of the second chondro-sternal articulation.
6. Interarticular ligament of the same joint.
7. Interarticular fibro-cartilage between the sternum and clavicle.

The *capsular ligament* (fig. 256, [1]) is a stout membrane surrounding the articular portions of the bones and the fibro-cartilage. Its fibres run obliquely from the clavicle downwards and inwards to the sternum. The stronger parts in front and behind are described as the *anterior* and *posterior sterno-clavicular ligaments*. Fibrous capsule.

The *interclavicular ligament* (fig. 256, [3]) extends above the sternum, between the ends of the clavicles. The fibres dip into the hollow between the collar-bones, and are connected with the upper edge of the sternum. Inter-clavicular

The *costo-clavicular* or *rhomboid ligament* (fig. 256, [2]) is a short strong band of oblique fibres, passing from the upper surface of the and costo-clavicular ligament.

cartilage of the first rib to a rough mark on the under surface of the clavicle near the sternal end. In front of the ligament is the origin of the subclavius muscle. Sometimes the ligament is hollow, and contains a synovial bursa.

Fibro-cartilage: attachments.

The *interarticular fibro-cartilage* (fig. 256, 7) will come into view by cutting the ligaments before described, and raising the clavicle. It is ovalish in form and flattened, and is thicker at the circumference than in the centre. Its upper margin is firmly united to the inner end of the clavicle ; and below, it is similarly fixed to the cartilage of the first rib. At its circumference it unites with the capsule of the joint. The fibro-cartilage is of considerable strength, and prevents the clavicle being displaced upwards or inwards.

Two synovial sacs.

Two *synovial sacs* are present in the articulation, one on each side of the fibro-cartilage. The external one is prolonged outwards for a short distance below, between the clavicle and the cartilage of the first rib.

Motion in four directions.

Movements. The clavicle can be moved upwards and downwards and forwards and backwards ; but the extent of movement in each direction is very limited, in consequence of the shortness of the ligaments surrounding the articulation : the forward and upward movements are freer than the opposite. In the upward and downward movements, the clavicle glides on the interarticular fibro-cartilage ; and when the shoulder is depressed, the inner end of the bone is raised, while elevation of the shoulder is accompanied by a sinking of the inner end of the clavicle. In the forward and backward movements, the fibro-cartilage glides in the same direction over the sternal articular surface. Dislocation may take place in any direction, except downwards ; but it is of rare occurrence owing to the strength of the ligaments.

CHAPTER X.

DISSECTION OF THE BRAIN.

SECTION I.

MEMBRANES AND VESSELS.

DIRECTIONS. The workers on the head and neck examine the brain together, and it is most desirable that, at the time of its removal from the head, they should obtain a second specimen, so that the minor cutting operations should be performed on one and the other left in its entirety till the study of the cerebral hemispheres is commenced. Notwithstanding this, however, the directions for dissection are given as far as possible so that one specimen should suffice. Both brains will be preserved according to the subjoined instructions.

A second specimen desirable.

Preservation and dissection. After the removal of the brain with its divesting membranes as directed on pp. 509 *et seq*, it should be thoroughly washed free of blood and then placed, with its under surface upwards, in a good-sized earthenware jar provided with a well-fitting cover. The brain should rest on a large, loose, pad of tow or cotton wool spread over the bottom of the jar, and the vessel should contain a 5 per cent. solution of formalin in water in sufficient quantities to cover the brain with a clear inch of liquid. The membranes and vessels, as described in this Section, should be examined as soon as possible after the specimen has been in the preservative for two days; for the reason that they are more easily traced whilst the preparation is still moderately soft, and that they can then be more readily removed without injury to the brain substance; moreover, it is necessary to remove them at an early stage in order to give the hardening fluid free access.

Preserve in formalin solution.

When the preparation is removed from the jar for the examination of the membranes and vessels, it should be well washed in running water to remove the adhering formalin solution, which is apt to be inconvenient to the dissector by the lachrymation it causes.

In describing the distribution of the blood vessels it is unavoidable to refer to various parts of the brain that have not yet been examined in detail, and it is therefore desirable that the student should have at hand a museum preparation in which the convolutions and sulci are clearly defined and marked (see fig. 270, p. 746, and fig. 273, p. 753).

SUBDIVISIONS OF THE ENCEPHALON. Before the description of the membranes and vessels is given, the chief subdivisions of the encephalon may be shortly noticed.

Outline of cranial mass. The cranial or encephalic mass of the nervous system (fig. 268, p. 741), consists of cerebrum or great brain, cerebellum or small brain, pons, and medulla oblongata. Each of these parts has the following situation and subdivisions :—

Medulla oblongata. The medulla oblongata, or bulb of the spinal cord (fig. 268, *a*), lies in the groove between the halves of the cerebellum, and is divided into two symmetrical parts by a median fissure. To it several of the cranial nerves are united.

Pons Varolii and its connections. The pons Varolii (*d*) is situate above the medulla oblongata, and is marked along the middle by a groove, which indicates a separation into halves and which lodges the basilar artery. Above it are two large processes (crura cerebri, *f*) connecting it to the cerebrum; and on each side it is united to the cerebellum by a similar white mass.

Cerebellum. The cerebellum (*b*), or the small brain, is separated into two hemispheres by a median groove ; and its surface is marked by concentric laminæ.

Cerebrum, and its great divisions. The cerebrum (*r* and *p*), or the large brain, is divided into two *hemispheres* by a longitudinal fissure in the middle line ; and each hemisphere presents a deep transverse cleft—the *fissure of Sylvius*. The surface of the hemispheres is convoluted.

Weight of brain. The average weight of the brain in the European male is about 49 oz. ; in the female about 44 oz.

Three membranes. MEMBRANES OF THE BRAIN. The coverings of the brain (meninges) are three in number, viz., dura mater, arachnoid, and pia mater. The dura mater is a firm fibrous investment, which separates and supports the different parts of the brain, and serves as an internal periosteum to the cranial bones. The pia mater is the most internal layer ; it is adherent to the brain substance and contains the ramifications of the vessels of the brain. The arachnoid, which is interposed between the other two, is the membrane that is seen when the brain is removed from the cranial cavity.

Besides enveloping the brain, these membranes are prolonged on the cord into the spinal canal. Only the cranial part of the last two will be now noticed. For the description of the cranial portion of the dura mater, see pp. 507 *et seq.*

Dura mater.

Arachnoid membrane : relations to sulci ; The ARACHNOID is a very thin fibrous membrane, which envelopes the brain loosely, and is separated from the dura mater by the interval named the *subdural space* and from the pia mater by the *subarachnoid space*. Its outer surface is free and smooth and in the natural state is in close apposition to the dura mater. The inner surface is attached to the pia mater by numerous fine cords and bands, which cross the subarachnoid space. The membrane covers the convolutions and laminæ of the large and small brain, bridging over the sulci between them, and at the under surface or *base* of the brain it stretches across from side to side between the cerebral

hemispheres, so as to leave a considerable space beneath it. Superiorly, it is prolonged into the median fissure between the cerebral hemispheres as far as the falx cerebri, but does not reach to the bottom of the cleft.

The arachnoid forms tubular sheaths on the nerves leaving the cavity of the cranium which enter the apertures in the dura mater, and then terminate in a free edge ; but around the vessels passing to or from the brain, the membrane joins the dura mater. sheaths on nerves and vessels.

The *subarachnoid space* is filled by a watery fluid named *cerebro-spinal*. The space varies greatly in size at different parts. Over the convolutions and prominences of the brain the arachnoid approaches the pia mater closely, and the interval between them is very small ; but opposite the sulci and depressions of the surface the space is expanded. The largest cavity (*cisterna magna*) is between the cerebellum and medulla oblongata, where the arachnoid is reflected from the one to the other, being widely separated from the pia mater which follows the surfaces. By an aperture in the pia mater at the depth of this space the subarachnoid space is placed in communication with the fourth and, ultimately, with the other ventricular cavities of the brain. Another considerable subarachnoid space (*cisterna basalis*) exists between the cerebral hemispheres in front of the pons with extensions outwards into the fissures of Sylvius and backwards to the cisterna magna ; and a third extends the whole length of the corpus callosum, in the great longitudinal fissure. Subarachnoid space varies in extent: three large cavities.

The PIA MATER closely invests the brain, following all inequalities of the surface, and dips into the sulci of the cerebrum and cerebellum. It also sends a large process, named the *velum interpositum*, into the interior of the cerebrum, and from this vascular processes known as the *choroid plexuses* project into some of the ventricles of the brain. Two similar fringes, the *choroid plexuses of the fourth ventricle*, similarly project into that cavity between the cerebellum and medulla oblongata. Pia mater forms velum interpositum and choroid plexuses :

The pia mater consists of a network of vessels, formed by the ramifications of the arteries and veins entering into, or issuing from the nervous substance, the intervals between the vessels being closed by connective tissue so as to form a continuous membrane. From its deep aspect minute and very numerous vessels pass into the brain perpendicularly to the surface ; and these can readily be seen as fine hair-like processes projecting from the membrane when a portion of it is stripped from the brain substance under water or when a piece of the freshly removed membrane is floated out in a dish. structure. How to show its vessels.

Vessels and nerves. The arachnoid has no vessels, but various anatomists have described minute branches of some of the cranial nerves in the membrane. The sources of the vessels of the pia mater are given below, and its nerves, which are probably destined for the vessels, come from several cranial nerves and the sympathetic. Vessels and nerves of membranes.

Dissection. First follow out the arteries at the base (fig. 257, p. 719), let the brain be upside down, and remove the arachnoid membrane. Having displayed the trunks of the *vertebral arteries* (12) Dissection of arteries

on the medulla oblongata, and those of the carotid near the median
of large brain, fissure of the large brain, the student should lay bare on one side the branches to the large brain. Define first the two arteries (*anterior cerebral*) lying in the median fissure (2) and joined by a short branch (3) (*anterior communicating*); next, an artery that passes outwards (4) in the fissure of Sylvius (*middle cerebral*), and pursue it to the outer surface of the hemisphere. Look then for a much smaller vessel (*anterior choroid*) which sinks into the brain on the outer side of the crus cerebri (5). Then by gently raising the cerebellum on the same side, the last artery of the cerebrum (*posterior cerebral*, 7) may be traced back round the crus cerebri to the inner part of the hemisphere.

and of small brain. Two principal arteries pass to the cerebellum. One on the upper surface (*superior cerebellar*) may be brought into view just behind the bifurcation of the basilar artery (8) and separated from the posterior cerebral by the third nerve. The fourth nerve runs beside it, and the cerebellum should be raised in tracing the vessel. Two other arteries (*anterior* and *posterior inferior cerebellar*) turn backwards and outwards from the vertebral, and may be easily followed.

The branches of the anterior, middle and posterior cerebral arteries will be followed out as they are described by removing the adhering membranes, by gently opening the fissures and sulci in which they partially lie, and by drawing them and their branches away from the brain substance as the work proceeds, and if care is taken no material injury will be done.

Arteries of the brain. ARTERIES OF THE BRAIN (fig. 257). The brain is supplied with blood by the vertebral and internal carotid arteries.

Vertebral The VERTEBRAL ARTERY (12) is a branch of the subclavian trunk and enters the skull through the foramen magnum; directed
ends in basilar, upwards and forwards round the medulla oblongata, it blends with its fellow in a common trunk (BASILAR) at the lower border of the
winds round medulla oblongata: pons. As the vessel winds round the medulla oblongata, it lies between the roots of the first cervical and hypoglossal nerves; but it is afterwards internal to the latter.

branches BRANCHES. Between its entrance into the spinal canal and its termination in the basilar, each artery furnishes offsets to the dura mater, to the spinal cord, and to the cerebellum.

to dura mater; *a*. The *posterior meningeal branch* leaves the trunk opposite the foramen magnum, and ramifies in the dura mater lining the cerebellar fossa of the occipital bone.

to spinal cord, *b*. The *posterior spinal branch* is of inconsiderable size, and arises opposite the back of the medulla oblongata: it descends along the
posterior and side of the cord, behind the nerves, and anastomoses with its fellow and with branches that enter by the intervertebral foramina.

anterior; *c*. The *anterior spinal branch* (13) is small like the preceding, and springs from the trunk opposite the front of the medulla. It joins the corresponding twig of the opposite side, and the resulting vessel is continued along the middle of the cord on the anterior aspect.

and to under part of cerebellum, *d*. The *posterior inferior cerebellar artery* (10) arises from the end of the vertebral (sometimes from the basilar), and winds backwards

round the medulla oblongata, between the pneumo-gastric and spinal accessory nerves, to the median groove of the cerebellum. Directed onwards in the sulcus between the hemisphere and the inferior vermiform process, the artery reaches the hinder margin of the cerebellum, and there anastomoses with the superior cerebellar artery.

An offset of this branch ramifies over the under part of the cerebellar hemisphere, and ends externally by anastomosing with the artery of the upper surface. As the vessel passes by the side of offsets.

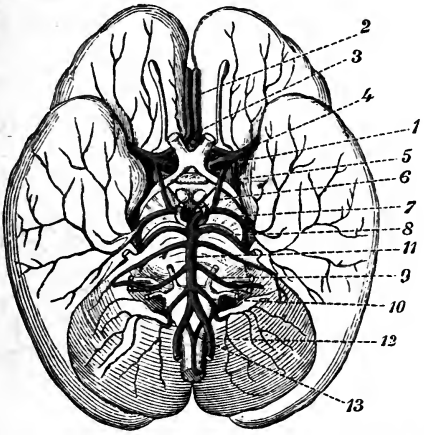


FIG. 257.—DIAGRAMMATIC REPRESENTATION OF THE ARTERIES AT THE BASE OF THE BRAIN.

1. Internal carotid trunk.
2. Anterior cerebral.
3. Anterior communicating.
4. Middle cerebral.
5. Anterior choroid.
6. Posterior communicating.
7. Posterior cerebral.
8. Superior cerebellar.
9. Auditory.
10. Posterior inferior cerebellar.
11. Basilar.
12. Vertebral.
13. Anterior spinal.

The anterior inferior cerebellar artery which passes outwards from the basilar behind No. 8 is not indicated by a pointer.

the fourth ventricle, it gives a small *choroid branch* to the plexus of that cavity.

The BASILAR ARTERY (11), formed by the union of the two vertebrals, reaches from the lower to the upper border of the pons, where it ends by dividing into two branches (posterior cerebral) for the cerebrum. The vessel lies in the median groove of the pons, resting against the body of the sphenoid bone. On each side of, and almost parallel to it, is the sixth nerve. Basilar artery: extent and situation;

BRANCHES. Besides the two posterior cerebral branches, the artery supplies transverse offsets to the pons and the fore part of the cerebellum, and a large branch to the upper surface of the cerebellum. branches;

transverse to the pons; *a.* The *transverse arteries of the pons* are four or five small twigs, which are named from their direction, and are distributed to the substance of the pons. One of them (9) gives an offset (*auditory*) to the internal ear along the auditory nerve.

auditory;

anterior cerebellar, *b.* Like the branches of this set is the *anterior inferior cerebellar artery:* it arises from the basilar trunk, and is distributed to the fore part of the under surface of the cerebellar hemisphere.

Superior cerebellar. *c.* The *superior cerebellar artery* (8) is a considerable vessel derived from the basilar so near the termination as to be often described as one of the final branches of that vessel. Its destination is the upper surface of the cerebellum, to which it is directed backwards, winding round the crus cerebri below the third, but parallel to the fourth

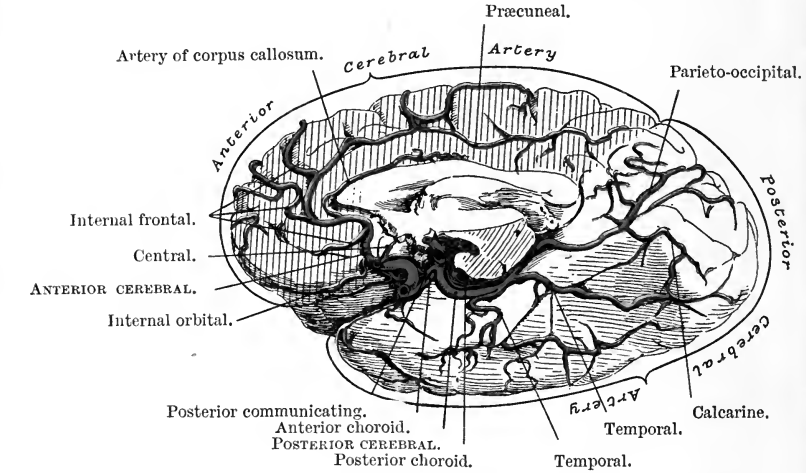


FIG. 258.—THE MESIAL AND UNDER SURFACES OF THE CEREBRAL HEMISPHERE, SHOWING THE DISTRIBUTION OF THE ANTERIOR AND POSTERIOR CEREBRAL ARTERIES.

nerve. The ramifications of the artery spread over the upper surface of the cerebellum, and anastomose with the vessel of the opposite side, and with the inferior cerebellar arteries.

giving offsets to velum. Some twigs of this vessel enter the fold of the pia mater (velum interpositum) which projects into the cerebrum.

Posterior cerebral artery *d.* The POSTERIOR CEREBRAL ARTERY (fig. 257, 7, and fig. 258) takes a backward course, similar to that of the preceding artery, but separated from it by the third nerve. It winds round the crus cerebri and is

branches of which are cortical, directed upwards and backwards to beneath the posterior end of the corpus callosum; it enters the calcarine fissure and divides into its two terminal branches, parieto-occipital and calcarine. Near its origin it is joined by the posterior communicating artery, passing backwards on each side from the terminal part of the internal carotid. The artery gives off numerous branches—

central, 1. The *deep* or *central arteries* leave the trunk close to its origin,

and enter the posterior perforated space between the crura cerebri, to supply the optic thalami in the interior of the brain. They are divided into two sets, those near the middle line and those further out, and are named respectively the *postero-mesial* and *postero-lateral* central arteries. two sets;

2. The *posterior choroid artery* (fig. 258) leaves the parent vessel as it winds round the crus and pursues a parallel course until it turns forwards beneath the posterior end of the corpus callosum to enter the velum interpositum and the choroid plexuses of the ventricles of the cerebrum. posterior choroid artery.

3. Two or more superficial, or cortical, *temporal branches* pass outwards from the artery in its course backwards and supply the under surface of the temporal lobe, except at the most anterior and most posterior parts. Cortical branches: Temporal.

4. The *calcarine* and *parieto-occipital*, like the foregoing, are cortical arteries. The calcarine runs into the posterior limb of the calcarine Calcarine.

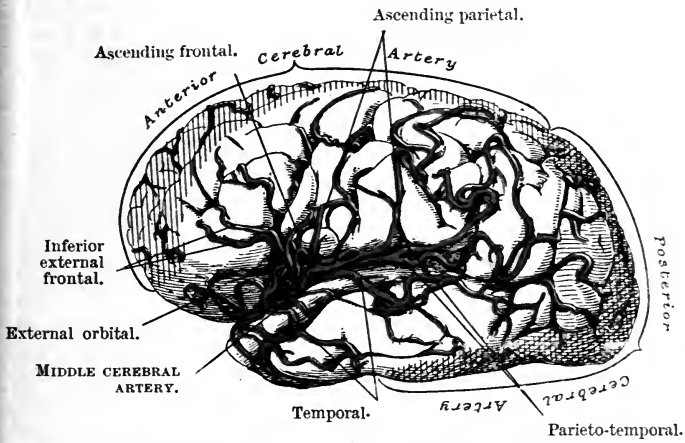


FIG. 259.—THE OUTER SURFACE OF THE CEREBRAL HEMISPHERE, SHOWING THE DISTRIBUTION OF THE MIDDLE CEREBRAL ARTERY.

fissure and supplies the back part of the fifth temporal convolution and the adjoining cuneus. The parieto-occipital branch runs mainly in the internal parieto-occipital fissure and supplies the front part of the cuneus and the back part of the pre-cuneate convolution. Parieto-occipital.

The posterior cerebral artery thus supplies the cortex of the cerebral hemisphere over the whole of the mesial aspect of the temporal (except the most anterior part) and occipital lobes, with a small part of the parietal (pre-cuneus); as well as a small part of the corresponding parts on their outer or convex surface (fig. 259).

From the foregoing examination of the offsets of the vertebral arteries and the basilar trunk, it appears that about half the brain—viz., the medulla oblongata, the pons, the cerebellum, and the Part of brain supplied by vertebral arteries.

posterior third of the cerebrum, as described—receives its blood through these branches of the subclavian arteries.

Internal carotid

The INTERNAL CAROTID ARTERY (fig. 257, [1]) terminates in branches for the remaining part of the cerebrum. The vessel emerges from the cavernous sinus internal to the anterior clinoid process, and

ends in cerebral arteries:

divides at the inner end of the fissure of Sylvius into cerebral and communicating arteries.

branches.

BRANCHES. In the skull the carotid gives off the *ophthalmic offset*, before it ends in the following branches (fig. 257) :—

a. Posterior communicating.
b. Anterior cerebral.
c. Middle cerebral.
d. Anterior choroid.

Posterior communicating.

a. The *posterior communicating artery* ([6]) is generally a small vessel, directed backwards on the inner side of the third nerve, to join the posterior cerebral artery near the pons.

Anterior cerebral artery:

b. The ANTERIOR CEREBRAL ARTERY (fig. 257, [2], and fig. 258) supplies the inner part of the cerebral hemisphere. It is directed forwards to the median fissure between the halves of the large brain ; and as it

its communicating,

is about to enter the fissure, it is united to its fellow by a short thick branch—the *anterior communicating* (fig. 257, [3]). Then passing into the fissure, it bends round the fore part of the corpus callosum, and is continued backwards along the upper surface of that body, sending its branches nearly to the posterior extremity of the hemisphere.

Its *branches*, like those of the posterior cerebral, consist of deep or *central* and superficial or *cortical* arteries.

central,

The *central branches* (*antero-mesial*) consist of two or three small offsets which arise near the beginning of the artery, and penetrate the anterior perforated space at the inner end of the fissure of Sylvius to reach the fore part of the corpus striatum in the interior of the hemisphere.

and cortical offsets.

The *cortical branches* supply the fore and upper parts of the internal surface of the hemisphere, extending backwards as far as the parieto-occipital fissure ; and some turn round the margin to the adjacent portions of the frontal lobe on both the upper and lower aspects.

They are named as follows :—(fig. 258).

1. Internal orbital.
2. Internal frontal.
3. Præcuneal.
4. The artery of the corpus callosum.

Internal orbital.

1. The *internal orbital* is distributed to the inner part of the under, or orbital surface of the frontal lobe.

Internal frontal.

2. The *internal frontal* are two or three branches given off from the convexity of the vessel as it winds round the anterior end of the corpus callosum, and are distributed to the whole of the mesial surface of the frontal lobe and to a small part of its outer or convex surface (fig. 259).

3. The *præcuneal* is a considerable vessel lying more or less in the calloso-marginal sulcus and distributed to the para-central and præcuneate convolutions as well as to the upper part of the callosal. Præcuneal.

4. The artery of the *corpus callosum* is a small vessel directed backwards in the callosal sulcus, and distributed to the corpus callosum and the lower part of the callosal convolutions. Artery of corpus callosum.

c. The MIDDLE CEREBRAL ARTERY (fig. 257, 4, and fig. 259) is the largest branch of the carotid, and ramifies over the outer surface of the hemisphere. Entering the fissure of Sylvius, it divides into four or five large *cortical branches*, which issue therefrom and supply the whole of the parietal lobe, together with the neighbouring parts of the frontal and temporal lobes. Middle cerebral artery: cortical

As the vessel enters the fissure of Sylvius it gives off the *antero-lateral* set of *central arteries*, which are the largest of their kind and pass upwards through the anterior perforated area to the central nuclei, supplying chiefly the lenticular and caudate nuclei of the corpus striatum and the intervening white matter of the internal capsule. and central branches. Antero-lateral set.

The origin of the *cortical* branches will be seen by opening out the fissure of Sylvius, as in fig. 259, and they are named as follows :— Cortical branches are

1. External orbital.
2. Inferior external frontal.
3. Ascending frontal.
4. Ascending parietal.
5. Parieto-temporal.
6. Temporal.

1. The *external orbital* is distributed to the outer part of the under, or orbital, surface of the frontal lobe. external orbital,

2. The *inferior external frontal* are two or three small branches which pass to the lower part of the outer surface of the frontal lobe. inferior external frontal,

3. The *ascending-frontal* is a considerable vessel lying more or less in the pre-central sulcus and distributed to the adjoining parts of the cortex. ascending frontal,

4. The *ascending-parietal* branch, like the foregoing, passes upwards; it is partially received into the post central sulcus, and is distributed to the cortex in its neighbourhood. ascending parietal,

5. The *parieto-temporal* are, usually, two large terminal vessels from the middle cerebral which emerge from the back part of the Sylvian fissure to pass to the outer surface of the back part of the parietal, the front of the occipital, and the contiguous portions of the temporal convolutions. parieto-temporal, and

6. The *temporal* branches are two or three in number: they emerge from the lower part of the Sylvian to the anterior part of the temporal lobe, and to the whole of its outer surface as far back as the preceding vessels. temporal.

On comparing figs. 258 and 259, it will thus be seen that the

cortical distribution of the anterior cerebral branch of the internal carotid is mainly on the mesial, whilst that of the middle cerebral is on the outer surface of the cerebral hemisphere.

Anterior choroid artery.

The *anterior choroid artery* (fig. 257,[5] and fig. 258), is small, and arises either from the trunk of the carotid, or from the middle cerebral artery: it passes backwards on the outer side of the posterior communicating artery, and makes its way between the hemisphere and the crus cerebri into the dentate fissure, at the bottom of which it enters the choroid plexus of the lateral ventricle.

Circle of Willis:

CIRCLE OF WILLIS (fig. 257). The arteries at the under part of the brain are united freely both on their own side and across the middle line in an anastomotic ring—the circle of Willis. On each

vessels that form it.

side this ring is formed by the trunk of the internal carotid giving forwards the anterior cerebral, and backwards the posterior communicating artery. In front it is constructed by the converging anterior cerebrals, and the anterior communicating artery. And behind is the bifurcation of the basilar trunk into the posterior cerebrals which receive the posterior communicating. In the area of the circle lie several parts of the brain corresponding with the floor of the third ventricle.

Use of the free inosculation.

The complete inosculation between the cranial vessels in the circle of Willis possibly allows at all times a free circulation of blood through the brain, even though a large vessel on one side of the neck should be obstructed.

Other anastomoses are small.

Beyond the circle of Willis the arteries of the cerebrum communicate together only by fine anastomoses.

Veins of the brain.

The VEINS of the brain enter the sinuses of the dura mater, and do not form companion trunks to the arteries.

Two sets to cerebrum:

Two sets of veins belong to the *cerebrum*, viz., superficial or external, and deep or internal.

external, which are upper and lower;

The *superficial veins* of the upper part of the hemisphere ascend to the superior longitudinal sinus; and those of the lateral and under parts enter the sinuses in the base of the skull, especially the cavernous and lateral sinuses. These vessels communicate freely together.

and internal.

The *deep veins* of the cerebrum join the veins of Galen (p. 764), and reach the straight sinus.

Veins of cerebellum.

The *veins of the cerebellum* end differently above and below. On the upper surface they are received by the veins of Galen and the straight sinus; and on the lower surface they terminate in the occipital and lateral sinuses.

Dissection.

Dissection. The pia mater and the vessels are now to be stripped from the brain, and the origin of the cranial nerves is to be carefully defined. Over the cerebrum and pons, the pia mater can be detached with tolerable ease by using two pairs of forceps; but on the cerebellum and the medulla oblongata the membrane adheres so closely as to require much care in removing it without tearing the brain-substance, or injuring the nerves.

Care to be taken in removing pia mater.

In clearing out the groove between the halves of the cerebellum

on the under surface, the membrane bounding the opening into the fourth ventricle will be taken away : therefore the position, size, and limits of that opening between the back of the medulla oblongata and the cerebellum should be now noted (p. 781).

When the surface has been cleaned, the brain is to be replaced in the formalin liquid, but it is to be turned over occasionally, so that all the parts may be hardened. A little additional formalin may be added from time to time to maintain the strength of the solution. The remaining Sections on the brain will be taken after the dissection of the head and neck is completed. Replace in formalin.

Section II.

GENERAL SURVEY OF THE BASE AND THE ORIGIN OF THE CRANIAL NERVES.

Directions. Now that the student enters upon the systematic dissection of the brain he is recommended to transfer the hardened preparation from the formalin solution to methylated spirit in order to avoid the inconvenience that arises from a close examination of specimens recently taken from the former liquid. Transfer brain to spirit.

For convenience sake a GENERAL SURVEY OF THE BASE OF THE BRAIN will be made first so that the student may be familiar with the names of the parts, although the structures mentioned will be examined again later. The base of the brain.

Beginning behind on the lower, or anterior, surface of the medulla oblongata (fig. 261, p. 732) is the *anterior median fissure* in the middle line ; on either side of this are two elongated eminences, the *anterior pyramids* (1) ; external to the pyramid below the pons Varolii is the oval *olivary body* (5) ; external to this is a narrow band, which, if traced downwards, appears to become continuous with the lateral tract (2) of the spinal cord, and beyond this, passing upwards into the cerebellum, is a large mass at the postero-external part of the medulla known as the *restiform body* (3). Emerging from the groove between the anterior pyramid and the olive are the roots of the twelfth nerve and in front of the restiform body a large number of nerve roots appear which belong to the ninth, tenth, and eleventh nerves. In front of the medulla the large mass of the *pons* (fig. 268 *d*, p. 741) passes across, and lying in the outer and back part of this is a convoluted piece of the cerebellum, the flocculus (*c*). Immediately in front of the pons are two large white masses, the *peduncles of the cerebrum* or *crura cerebri* (*f*), one belonging to each hemisphere ; and between them is a small area perforated by vessels, which is named the *posterior perforated space* (*g*). Crossing the peduncle is the *optic tract ;* and between it and the inner part of the hemisphere is a fissure leading into the lateral ventricle. Parts of the medulla and pons. Enumeration of central parts.

In front of the posterior perforated space are seen two rounded

Parts in front of the crura cerebri.

white bodies—the *corpora albicantia* (*e*); and then a prominent greyish mass, called *tuber cinereum* (*h*). From the tuber cinereum a conical process, the *infundibulum*, descends to the pituitary body in the sella Turcica of the sphenoid bone.

Anterior to the tuber cinereum are the converging optic tracts with their *commissure* (*i*). In front of the commissure lies a thin greyish layer—*lamina cinerea* (*m*): and still farther forwards is the great longitudinal fissure between the hemispheres, with the white *corpus callosum* (*n*) in the bottom of it.

At the inner end of the Sylvian fissure is a depression termed the *vallecula Sylvii* (*l*), at the bottom of which is seen another spot perforated by vessels—the *anterior perforated space.*

Olfactory lobe.

Lastly, in front of the anterior perforated space, and resting on the surface of the frontal lobe of the cerebral hemisphere, is the elongated process of the brain (*o*) named the *olfactory lobe*, from which the olfactory nerve-filaments spring. This process is frequently called the olfactory nerve, but its true nature as a lobe of the cerebrum is shown by its position and structure, as well as by its condition in the lower animals, in which it is generally of large size.

Definition.

The CRANIAL NERVES take origin from the encephalon, with one exception, the spinal accessory, and pass through apertures in the wall of the cranium.

Origin is apparent and real.

The origin of a nerve is not determined by the place at which it appears on the surface, for fibres or roots may be traced deeply into the brain-substance. Each nerve has therefore a *superficial* or apparent, and a *deep* or real origin.

With respect to the superficial attachment there cannot be any doubt; but the deep origins, in consequence of the difficulty of tracing the roots, are matters for the most part outside the possibilities of ordinary dissection. When the roots are followed into the encephalon, they enter masses of grey substance, containing nerve-cells, which are looked upon as *nuclei of origin* in the case of motor nerve fibres or *of termination* in the case of sensory, or afferent, fibres.

Real is from grey matter.

Classification as twelve pairs. Sœmmering's.

The cranial nerves are enumerated as forming twelve pairs. According to this arrangement (Sœmmering's) each trunk is considered a separate nerve, although it may be associated with others in the foramen of exit.

Designation from number,

The several nerves may be designated first, second, third, and so forth: this numerical mode of naming applies to all.

name of part,

But a second name has been derived for some of the nerves from the parts to which they are supplied; as instances of this nomenclature the terms pneumo-gastric and hypoglossal may be taken.

or function.

A different appellation is given to others, in consequence of the function conferred on the part to which they are distributed, as the terms auditory, oculomotor and olfactory express. In this way two names may be employed in referring to a nerve:—one being numerical, the other local or functional, as is exemplified below.

Olfactory nerves.

The FIRST OR OLFACTORY NERVES are about twenty fine filaments which spring from the under surface of the olfactory bulb (fig. 260, [1])

They are very soft, and break off close to their origin when the brain is removed from the skull.

The SECOND or OPTIC (fig. 260, 2) is the largest of the cranial nerves except the fifth, and appears on the crus cerebri as a flat band (*the optic tract*), which is directed inwards to join the one of the opposite side in a commissure. The name *optic nerve* is confined to the portion in front of the commissure which is round and firm. The destination of the nerve is the eyeball. Second nerve is optic: part called tract.

The *optic tract* winds round the crus cerebri to end, in front in Optic tract:

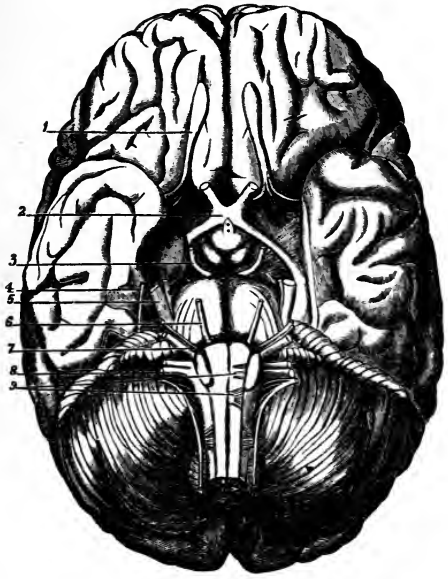


FIG. 260.—BASE OF THE BRAIN, WITH ORIGIN OF THE CRANIAL NERVES.

1. Olfactory lobe.
2. Optic commissure.
3. Oculomotor.
4. Trochlear.
5. Trigeminal, with small and large root.
6. Abducent.
7. Facial and auditory, the former smaller and internal.
8. Glosso-pharyngeal, pneumogastric, and spinal accessory nerves, in order from above downwards.
9. Roots of hypoglossal nerve.

the commissure. Behind it divides into two pieces which will be subsequently seen to take their origin from the optic thalamus, the corpus geniculatum externum, and the superior corpus quadrigeminum. As the tract passes forwards it is attached to the crus cerebri by its outer or anterior edge; and internal to the crus it is placed between the anterior perforated spot on the outer, and the tuber cinereum on the inner side; it is said to be joined here by additional fibres springing from the latter body. origin now concealed; relations.

The *commissure* (chiasma) of the nerves measures nearly half an Its commissure:

situation, inch across, and lies on the olivary eminence of the sphenoid bone, within the circle of Willis. It is placed in front of the tuber cinereum; and passing beneath it (in this position of the brain) is the thin lamina cinerea.

arrangement of fibres. In the commissure each tract is resolved into three sets of fibres with the following arrangement:—The outer fibres, few in number, are continued straight to the temporal side of the eyeball of the same side. The middle, the most numerous, decussate with the corresponding fibres of the other tract,—those of the right tract being continued into the inner part of the left nerve and passing to the nasal portion of the opposite eye, and *vice versâ*. The most internal fibres are continued across the back of the commissure into the tract of the other side back to the brain without entering the eye, and are not visual fibres.

Trunk of nerve. The *optic nerve* extends from the commissure to the eyeball, and is about one inch and a half in length. It leaves the skull by the optic foramen, where it receives its sheaths from the dura mater and arachnoid and crosses the orbit to end in the retina.

Origin of the third nerve: The THIRD or OCULOMOTOR NERVE (3) is round and firm, and is attached by a series of filaments along an oblique groove on the inner side of the crus cerebri, near the posterior perforated space, and close in front of the pons Varolii.

deep in crus cerebri. *Deep origin.* The fibres of the nerve traverse the crus in their course from a nuclear origin in the grey substance in the floor of the aqueduct of Sylvius beneath the anterior corpus quadrigeminum.*

Fourth nerve from cerebellum: The FOURTH or TROCHLEAR NERVE (4) cannot be followed backwards at present to its origin. It is the smallest of the cranial nerves, and emerges on the upper surface of the crus behind the posterior corpus quadrigeminum through the valve of Vieussens (fig. 277, 4, p. 765). The nerve appears at the base between the cerebrum and cerebellum on the side of the crus cerebri, and is directed forwards to enter an aperture in the free edge of the tentorium cerebelli near the posterior clinoid process.

nucleus in floor of Sylvian aqueduct. *Deep origin.* In the valve of Vieussens the nerve crosses to the opposite side, decussating with its fellow, and then arches round the aqueduct of Sylvius to reach its nucleus in the floor of that canal, immediately behind the nucleus of the third nerve.

Fifth nerve has two roots, The FIFTH or TRIGEMINAL (5) is the largest of the cranial nerves, and consists of two roots, ganglionic or sensory, and aganglionic or motor, which are separate to beyond the ganglion.

both issuing from pons. The nerve emerges from the side of the pons Varolii, nearer the upper than the lower border. The small or aganglionic root is the higher, and is separated from the large root by one or two of the transverse bundles of the pons. Both roots pass outwards through an aperture in the dura mater, above the petrous part of the temporal bone into the cavum Meckelii, as already described, p. 516.

* The position of the nuclei of this and the following nerves is roughly shown on fig. 287, on p. 783.

Deep origin. The *large root* divides within the pons into two parts. One of these is connected with a mass of grey matter (sensory nucleus of the fifth) near the floor of the fourth ventricle: the other (ascending root of the fifth; fig. 267 Va, p. 739) arises from the cells of the posterior horn of the grey matter in the lower part of the medulla oblongata and upper part of the spinal cord, and is directed upwards on the outer surface of the gelatinous substance of Rolando to join the upper part. Deep origin of large root in pons and medulla oblongata;

The *small root* also has a double origin, one part springing from a special nucleus (motor nucleus of the fifth) in the floor of the fourth ventricle internal to the sensory nucleus, and the other (descending root of the fifth; fig. 283, p. 775) from a collection of nerve-cells on the side of the aqueduct of Sylvius. of small in pons and mid-brain.

The SIXTH NERVE (6), abducent nerve of the eyeball comes through the outer part of the anterior pyramid close behind the pons, and often by a second band from the lower border of the pons. Sixth nerve from pyramid,

Deep origin. The fibres of the nerve pass forwards, through the lower part of the pons, from a nucleus in the floor of the fourth ventricle, beneath the outer part of the fasciculus teres (fig. 267). and nucleus beneath fourth ventricle.

The SEVENTH OR FACIAL NERVE (7) appears at the lower border of the pons, to which it is closely adherent, in the depression between the upper ends of the olivary and restiform bodies. A small accessory bundle (*portio intermedia* of Wrisberg) leaves the medulla oblongata between the facial and the auditory nerves, and joins the former within the internal auditory meatus. Seventh nerve from lateral tract of bulb: joined by intermediate portion.

Deep origin. The fibres of the facial nerve pass backwards to the floor of the fourth ventricle, and there wind round the nucleus of the sixth nerve, to arise from a group of nerve-cells lying in front and to the outer side of the latter (fig. 267). Whether some of the fibres are connected with the cells of the nucleus of the sixth is uncertain. Deep origin from a nucleus in dorsal part of pons.

The EIGHTH OR AUDITORY NERVE has a surface attachment outside the foregoing to the restiform body internal to the flocculus; one of its roots passing round the restiform body to its dorsal surface. Eighth nerve from restiform body.

Deep origin. At its attachment to the medulla oblongata, the auditory nerve consists of two roots, upper and lower. The fibres of the upper or dorsal part constitute the *cochlear division* of the nerve, some of its fibres terminate in cells forming the ventral cochlear nucleus on the under part of the restiform body, and others pass to the dorsal cochlear nucleus (outer auditory nucleus) in the lateral angle of the floor of the fourth ventricle dorsal to the restiform body. The fibres of the striæ acusticæ arise from the latter nucleus, and they, with many more from the ventral nucleus, eventually pass, through the intervention of the superior olivary nucleus and other groups of cells, into the lateral fillet and are connected with the posterior corpus quadrigeminum. Deep origin. Cochlear division.

The lower, or ventral part of the auditory nerve constitutes the *vestibular division*. Many of its fibres pass through the pons, internal to the restiform body to the inner auditory nucleus, or the dorsal vestibular nucleus, beneath the auditory tubercle in the floor of the fourth ventricle; other fibres pass to groups of large cells internal to and beneath the restiform body forming the nucleus of Deiters, and some to a group of cells styled the nucleus of the descending root. Many fibres from the dorsal nucleus of the vestibular division of the auditory nerve pass through the restiform body into the cerebellum. Vestibular division.

The NINTH OR GLOSSO-PHARYNGEAL NERVE (8) leaves the medulla Ninth nerve below facial

oblongata by five or six filaments close below the facial nerve, in the groove between the olivary and restiform bodies.

nucleus in floor of fourth ventricle.

Deep origin. Directed backwards through the medulla oblongata, the fibres join a main nucleus beneath the inferior fovea in the floor of the fourth ventricle. A considerable bundle of fibres passes to the *fasciculus solitarius* in the medulla and upper part of the cord, and some motor fibres spring, with others of the vagus, from the *nucleus ambiguus* in the medulla.

Tenth nerve below ninth

The TENTH, VAGUS OR PNEUMO-GASTRIC NERVE (8) issues by a number of filaments (twelve to fifteen) from the medulla oblongata in a line with, and below the glosso-pharyngeal.

nucleus beneath fourth ventricle.

Deep origin. Taking a similar course in the medulla oblongata to the roots of the ninth nerve, the fibres of the vagus reach their main nucleus beneath the calamus scriptorius of the fourth ventricle. Other fibres pass to the fasciculus solitarius, and others spring from the small nucleus ambiguus in the medulla.

Eleventh nerve in two pieces;

The ELEVENTH OR SPINAL ACCESSORY NERVE consists of two parts —accessory to the vagus, and spinal.

accessory from medulla oblongata,

The *accessory* or *bulbar part* is of small size, and is formed by the union of slender filaments continuing the line of the glosso-pharyngeal and vagus nerves along the medulla oblongata, as low as the first cervical nerve. After communicating with the spinal part in the jugular foramen, it passes into the vagus nerve outside the skull.

spinal from cord.

The *spinal part* is firm and round, like the third or the sixth nerve, but only a small piece of it can now be seen. It arises by a number of fine filaments from the lateral column of the spinal cord as low as the sixth cervical nerve. As the nerve ascends along the side of the cord it lies between the ligamentum denticulatum and the posterior roots of the spinal nerves, with the upper of which it may be connected. It enters the skull by the foramen magnum.

Both from one nucleus.

Deep origin. The fibres of both accessory and spinal parts have been traced inwards to an elongated column of cells reaching from the lower third of the olivary body to the level of the fifth cervical nerve, and situate, in the spinal part of its extent, in the outer part of the anterior horn of the grey matter, and, in the medulla oblongata, behind and to the outer side of the hypoglossal nucleus.

The ninth, tenth, and eleventh nerves converge below the crus cerebelli, and rest on the flocculus. From that spot they are directed outwards to the jugular foramen.

Twelfth nerve from front of medulla oblongata:

THE TWELFTH OR HYPOGLOSSAL NERVE (9) appears on the front of the medulla oblongata, where it is attached by a series of filaments (ten to fifteen) along the groove between the pyramid and the olivary body, in a line with the anterior roots of the spinal nerves. The filaments of origin unite into two bundles, which pierce the dura mater separately, and unite at the outer part of the anterior condylar foramen.

nucleus near central canal and fourth ventricle.

Deep origin. The roots of the nerve can be followed through the medulla oblongata to a nucleus, which is placed in front of the central canal below, and extends upwards into the lower part of the fasciculus teres in the fourth ventricle.

Section III.

MEDULLA OBLONGATA AND PONS VAROLII.

The medulla oblongata and the pons are interposed between the spinal cord and the brain proper.

Dissection. On a single brain the student may learn nearly all the anatomy of the medulla and pons ; but if he has a second brain he should cut through the crus cerebri above the cerebellum immediately behind the posterior corpus quadrigeminum and then carefully take away the cerebellum from the pons and medulla by cutting through the attachments close to the cerebellum, opening out thereby (fig. 262, p. 733), the fourth ventricle and exposing the upper surfaces of the pons and medulla. Dissection.

Position. The brain is to remain in the same position as for the examination of the vessels and nerves. Position.

The MEDULLA OBLONGATA or BULB is the expanded upper end of the spinal cord which is contained in the cranium. Its limits are the lower border of the pons in one direction, and the lower margin of the foramen magnum in the other. It is somewhat conical in form, and measures nearly an inch in length, half an inch in breadth below, and about an inch at its widest part above. Medulla oblongata: extent form and size.

Its base joins the pons, the transverse fibres of the latter marking its limit ; and its apex is blended with the spinal cord. The anterior surface (fig. 261) is irregularly convex, and is in contact with the hollowed basilar process of the occipital bone. The opposite surface (fig. 262) is convex below, and somewhat excavated above, where it forms the floor of the fourth ventricle ; it rests in the groove between the hemispheres of the cerebellum, and on this posterior or upper aspect there are not any cross fibres of the pons, as in front, to mark the limit of the bulb. Base. Apex. Surfaces.

The medulla oblongata is divided into halves by a median fissure in front and behind, in a line with those of the cord. The *anterior median fissure* is interrupted at the lower end of the bulb by some bundles of fibres which cross obliquely from one side to the other, and constitute the *decussation of the pyramids ;* above, it ends at the lower border of the pons in a dilatation (foramen cæcum). The *posterior median fissure* is continued upwards from the cord through the lower half of the medulla oblongata, and then terminates by the separation of its lateral boundaries to form the sides of the fourth ventricle. Median fissures, anterior and posterior.

On each half of the medulla oblongata are elongated eminences, separated by slight grooves, and continuous with the columns of the spinal cord ; but they receive different names in this part of their extent, and some fresh bodies are added. Thus, the part continuing the anterior column of the cord, by the side of the anterior median fissure, is known as the *anterior pyramid* (fig. 261, [1]). The prolongation of the lateral column takes the name of *lateral tract* ([2]), the Surface constituents partly continued from cord, partly new.

position of which is occupied in the upper half of the bulb by an oval eminence called the *olivary body*. Continuing the posterior column is the *funiculus cuneatus* (fig. 262, *fc*), which is separated from the lateral tract by a smaller eminence to which the name of *funiculus of Rolando* (R) has been given: in the upper part of the medulla these are succeeded by, or become lost on, the *restiform body* (fig. 261, [3]; fig. 262, *rb*) projecting outwards towards the cerebellum. And lastly, between the funiculus cuneatus and the posterior median fissure is the *funiculus gracilis* (fig. 262, *fg*) continued from the posterior median column of the cord.

Pyramid.

The *anterior pyramid* is placed between the anterior median fissure on the inner side and the lateral tract with the olivary body on the outer side. It increases in size from below upwards, whence its name; but at the upper end it is somewhat constricted and rounded just before it disappears beneath the superficial transverse fibres of the pons. This body is only in small part prolonged from the anterior column of the cord, its inner and larger portion being formed by the decussating fibres seen in the anterior median fissure.

FIG. 261.—MEDULLA OBLONGATA AND PONS FROM BEFORE.

1. Pyramid.
2. Lateral tract.
3. Restiform body.
5. Olivary body.
6. Decussation of pyramids.

Lateral tract.

The *lateral tract* in the lower half of the medulla oblongata is of the same width as the lateral column of the cord; but above, it is reduced to a narrow strip along the bottom of the groove between the olivary and restiform bodies.

Olive.

The *olivary body* is oval in shape and about half an inch long. Its upper end, which is more prominent than the lower, does not quite reach the pons. Internally it is separated from the anterior pyramid by a narrow groove along which the hypoglossal nerve arises; and externally from the restiform body by a broader one, where the glosso-pharyngeal and vagus nerves issue.

Funiculus and tubercle of Rolando.

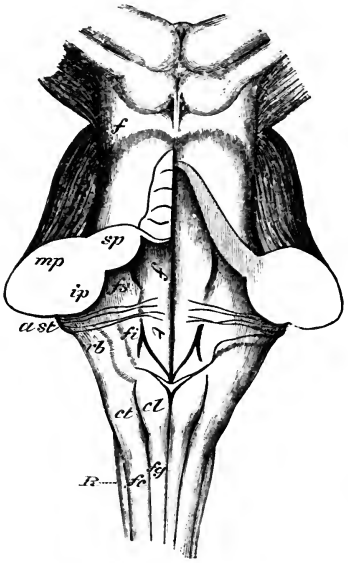
The *funiculus of Rolando* begins in a pointed extremity at the lower end of the medulla oblongata, and enlarging upwards forms, on a level with the lower end of the olivary body, a slight prominence known as the *tubercle of Rolando*. Towards the front this funiculus is separated from the lateral tract by the continuation upwards of the lateral groove of the cord; but posteriorly the line of separation from the cuneate funiculus is often indistinct. The funiculus and tubercle of Rolando are better marked in the child, and the tubercle

has then a greyish colour, whence the name *tuberculum cinereum* is also given to it.

The *funiculus cuneatus* is the prolongation of the posterior column of the cord, and forms a swelling—*tuberculum cuneatum* (fig. 262, *ct*), opposite the lower extremity of the fourth ventricle. Cuneate funiculus and tubercle.

The *restiform body* is the largest of the prominences of the medulla oblongata, and appears to be the continuation of the funiculus of Rolando and the funiculus cuneatus. It inclines outwards above, and enters the hemisphere of the cerebellum, of which it constitutes the inferior peduncle. On the back of the medulla oblongata, the inner margin of this body forms the lateral boundary of the lower part of the fourth ventricle. Restiform body.

The *funiculus gracilis* (posterior pyramid) lies by the side of the posterior median fissure, and is the smallest of the parts of the medulla oblongata. It ends above in an enlargement termed the *clava* (fig. 262, *cl*), which bounds the lower point of the fourth ventricle.



Slender funiculus and clava.

Superficial arciform fibres.

On the anterior surface of the medulla oblongata there may be seen, more or less distinctly in different subjects, a set of fibres crossing transversely to the restiform body over the upper half of the pyramid and the olivary body. These are the *superficial arciform fibres.*

FIG. 262.—MEDULLA OBLONGATA AND PONS FROM BEHIND.

fg. Funiculus gracilis.
cl. Clava.
fc. Funiculus cuneatus.
ct. Cuneate tubercle.
R. Funiculus of Rolando.
rb. Restiform body.
a st. Auditory striæ.
ft. Fasciculus teres.
sp. Superior peduncle (cut).
mp. Middle peduncle (cut).
ip. Inferior peduncle (cut).

Internal structure of medulla oblongata.

STRUCTURE. The fibres of the several columns of the spinal cord enter the medulla oblongata below, where they undergo a partial re-arrangement and are partly continued onwards to the cerebrum and cerebellum, being joined by other fibres which take their origin in the bulb, and they partly end in the grey substance of the medulla oblongata. The course of the fibres can only be shown to a very small extent by dissection, and for the complete study of the arrangement of the fibres, as well as of the grey matter, it is necessary to examine sections of different parts of the medulla oblongata.

Dissection. In tracing out groups of fibres in the hardened brain the student will use the knife very little, but he will find that by Dissection to trace pyramid.

taking hold of a bundle of fibres in the forceps or fingers and gently tearing them up that they will separate in their proper direction. To expose the connection of the pyramid with the spinal cord he should take hold of with the forceps and turn outwards on the left side, as in fig. 263, the small part of the anterior column of the cord at the lowest part of the specimen (which will be below the decussation), and the pyramid of the right side will then be seen to divide below into two parts, one passing directly into the anterior column, and the other crossing the median fissure and disappearing in the opposite half of the cord. Similarly an incision about $\frac{1}{8}$th

How to expose the pyramidal fibres.

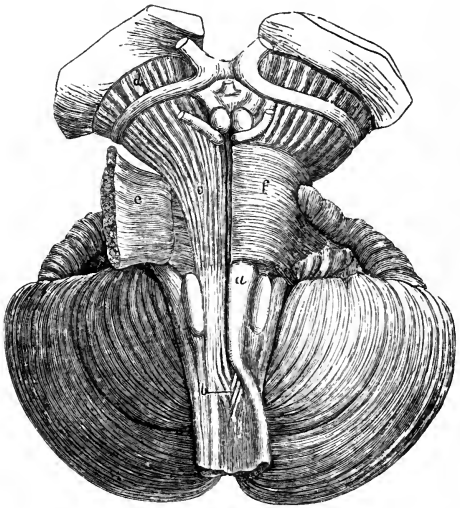


FIG. 263.—SUPERFICIAL DISSECTION OF THE MEDULLA OBLONGATA AND PONS.

a. Anterior pyramid.
b. Decussation of the pyramids.
c. Pyramidal fibres in the pons.
d. The same in the crus cerebri.
e. Superficial fibres of the pons, cut through and reflected.
f. Superficial fibres of the pons, in place.

of an inch deep will be made in the middle line of the pons and its superficial fibres stripped transversely and the pyramidal fibres carefully cleaned upwards on the right side, when they will be found to pass into the lowest part (crusta) of the crus cerebri.

Fibres of the pyramid

Pyramid and anterior column. The fibres of the pyramid form a well-defined and independent bundle (seen in section on fig. 265 *a*, p. 736) through the whole extent of the medulla oblongata, and are continued below partly into the anterior column of the same side of the cord and partly into the lateral column of the opposite half. The set of fibres keeping to the same side forms the outer portion of the pyramid, but in the anterior column of the cord, where it is known as the *direct pyramidal tract*, it is placed close to the anterior

direct,

edian fissure. The decussating fibres are the more numerous, and ass obliquely backwards, across the median fissure and behind the pposite anterior column, to enter the lateral column of the cord, where hey constitute the *crossed pyramidal tract*. Upwards, the fibres of the yramid are prolonged through the pons to the crusta of the cerebral eduncle (fig. 263, *c*, *d*). The fibres of the anterior column of the ord which are not continued into the pyramid incline backwards, and crossed. Rest of anterior column.

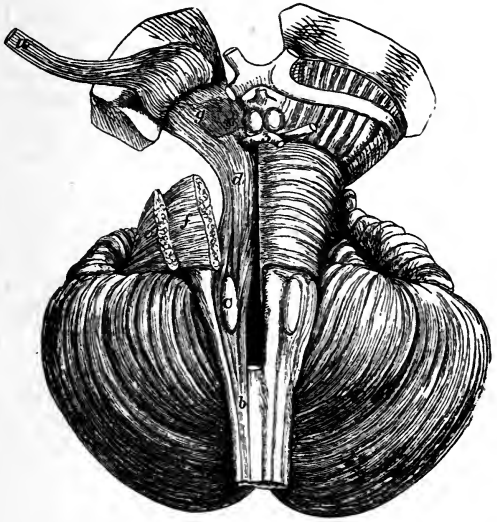


FIG. 264.—DEEP DISSECTION OF THE MEDULLA OBLONGATA, PONS, AND CRUS CEREBRI.

a. Pyramidal fibres, cut through, and raised as far as the optic thalamus.
b. Lateral tract.
c. Olivary body.
d. Deep longitudinal fibres in the pons, derived from the anterior and lateral columns of the cord.
e. Superficial, and *f*, deep transverse fibres of the pons, cut through, and partly removed.
g. Substantia nigra in the crus cerebri, between the crusta and tegmentum.

and enter the reticular formation (fig. 265, *k*, *l*) in the deeper parts of the medulla oblongata.

The *decussation of the pyramids* (fig. 263, *b*) occupies the anterior fissure of the medulla oblongata at a distance of three-quarters of an inch below the pons. It is about a quarter of an inch in length, and is generally constructed by the crossing of three or four bundles of fibres from each side, but the proportion of the pyramidal fibres which decussate in the medulla varies much in different individuals. Decussation of pyramids. varies in extent.

Dissection. For the purpose of seeing the deeper fibres of the medulla oblongata, the pyramid may be cut across on the right side just below the olivary body (fig. 264) and raised towards the pons. Dissection.

Fibres of lateral tract.

The *lateral tract* is composed of the remaining fibres of the lateral column of the cord, after the crossed pyramidal tract has been given off. Most of these pass deeply behind the olivary body, and through the reticular formation to the pons; but one small band, the *direct cerebellar tract*, is continued superficially from the lateral column to the cerebellum. This band is often visible on the surface of the medulla, as a whiter streak lying along the outer edge of the lateral tract, and inclining backwards above the tubercle of Rolando to join the restiform body.

Direct cerebellar tract.

Fibres of funiculus cuneatus, gracilis, and of Rolando.

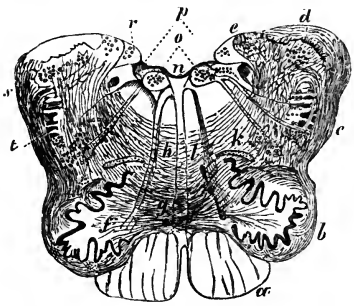


FIG. 265.—TRANSVERSE SECTION OF THE MEDULLA OBLONGATA AT THE LOWER PART OF THE FOURTH VENTRICLE (CLARKE).

Formation of restiform body.

a. Pyramid.
b. Olivary body.
c. Tubercle of Rolando.
d. Restiform body.
e. Lateral boundary of fourth ventricle.
f. White core of the olivary body, with the roots of the hypoglossal nerve to its inner side.
g. Olivary peduncle.
h. Deep arciform fibres entering the raphé (a few more are added from a second drawing).
k.l. Reticular formation.
n. Floor of fourth ventricle.
o. Hypoglossal nucleus.
p. Glosso-pharyngeal nucleus.
r. Inner auditory nucleus.
s. Superficial arciform fibres.
t. Remains of the gelatinous substance.

Posterior funiculi. The white fibres of the cuneate and slender funiculi are the continuation of the postero-external and postero-median columns of the cord respectively, and are believed to end entirely in the grey nuclei of the funiculi. The funiculus of Rolando has only a very thin superficial white layer, which is also derived from the posterior column.

The *restiform body* is formed by the arciform fibres of the medulla, by the direct cerebellar tract, by fibres from the gracile and cuneate nuclei and from the vestibular portion of the auditory nerve.

Dissection. The separated pons and medulla will now be divided longitudinally. One half we will put aside. On the other, by making transverse sections at different levels, the student will be able to distinguish the grey matter of the olivary body and a few other larger nuclei as well as the chief bundles of white fibres, but the parts described in small type require specially stained sections for their proper display.

Arciform fibres:

Arciform fibres. In the upper half of the medulla oblongata, covering its anterior surface and traversing its substance, is an extensive system of fibres, curving outwards and backwards from the median plane to the restiform body, to which this name has been given.

superficial,

The *superficial arciform fibres* (fig. 265, *s*) have already been noticed in the description of the exterior of the medulla oblongata.

The *deep arciform fibres* (*h*) are more numerous, and are seen over the whole area of transverse sections except in the pyramid. Some of them come to the surface on the inner side of, and through the olivary body, and join the superficial set. Others are deep in their whole extent, and pass outwards into the restiform body, and to the nuclei of the cuneate and slender funiculi. Internally, the arciform fibres enter the raphé, through which they are continued to the opposite half of the bulb. and deep.

The *raphé* (between *h* and *l*) occupies the median plane of the medulla oblongata above the decussation of the pyramids, and consists of fibres running obliquely, longitudinally, and from before backwards, which are in part continuous with the superficial and deep arciform fibres, and in part spring from the nuclei in the floor of the fourth ventricle. Raphé.

Formatio reticularis. In the dorsal portion of the medulla oblongata, behind the pyramid and olivary body (*l* and *k*), the longitudinal fibres derived from the anterior and lateral columns of the cord, decussating with the deep arciform fibres, give rise to a structure that is known as the *recticular formation of the bulb.* In the part of the reticular formation behind the olivary body (*k*) interspersed grey matter containing nerve-cells is also present. Reticular formation.

Olivary body (fig. 265, *f*). On removing a thin slice from the olivary body, it will be seen to consist of three parts, viz., an external investment of white substance, a thin grey layer, the olivary nucleus, and a central white core. Olivary body:

The outer white layer consists mainly of transverse fibres, which belong to the superficial arciform group.

The *olivary nucleus* or *corpus dentatum* is a thin plaited capsule or bag, having a zigzag outline in section. Towards the surface and behind it is closed, but on the inner side it is open, forming a narrow neck, which is turned towards the raphé, and gives passage to the olivary peduncle. its nucleus,

The central white matter fills the grey capsule, and is formed by the spreading out of a tract of white fibres called the *olivary peduncle*, which passes inwards through the opening in the nucleus to the raphé. The fibres of the peduncle partly terminate in the cells of the corpus dentatum, and are partly continued through the grey layer to join the arciform fibres. and peduncle.

Grey matter of the medulla oblongata. The larger part of the grey matter in the bulb is a continuation of that of the cord, but there are in addition some smaller independent masses. Grey matter of bulb

Prolongation of grey matter of the spinal cord. At the lower end of the medulla oblongata the central grey matter resembles that in the spinal cord, but as it extends upwards it undergoes the following changes :— prolonged from cord.

The anterior cornu is broken up by the passage through it of the fibres of the crossed pyramidal tract, and the detached extremity of the horn is continued upwards in the lateral tract for some distance as the *lateral nucleus.* Changes in anterior horn,

The posterior cornu is pushed outwards by the increasing development of the gracile and cuneate funiculi, and its extremity (caput), consisting of the substantia gelatinosa of Rolando, becomes greatly enlarged and approaches the surface, giving rise to the funiculus and tubercle of Rolando (fig. 265, *c*). From the base of the horn, processes of the grey matter extend backwards into the slender and cuneate funiculi, and are known as the nuclei of those bodies. They are largest in the neighbourhood of the lower end of the fourth ventricle, where they cause the swellings which have been described above as the clava and cuneate tubercle (p. 733). in posterior horn,

By the opening out of the posterior median fissure and central canal of the cord to form the fourth ventricle, the anterior portion of the grey commissure and in commissure.

and the bases of the anterior horns are exposed, constituting the grey layer in the floor of that cavity.

Special grey masses.

Special deposits of grey matter. These are the olivary nucleus, which has just been examined, some groups of nerve-cells at the back of the medulla oblongata forming nuclei of origin for several cranial nerves, which will be noticed in connection with the anatomy of the fourth ventricle, and a few small masses of grey substance of the front of the medulla beneath the superficial arciform fibres.

Pons Varolii.

Pons: position,

The PONS VAROLII is situate above the the medulla oblongata, and between the hemispheres of the cerebellum. In its natural position in the skull it lies below the opening in the tentorium cerebelli,

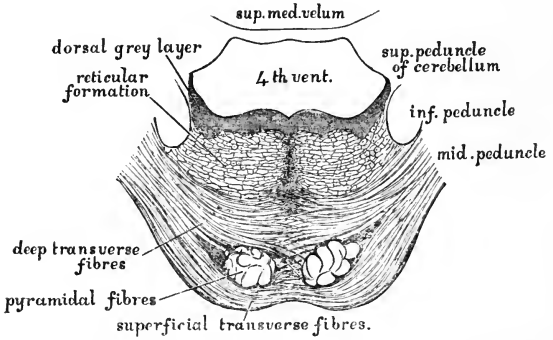


FIG. 266.—DIAGRAM OF A TRANSVERSE SECTION THROUGH THE LOWER PART OF THE PONS, SHOWING ITS CHIEF CONSTITUENTS.

form,

resting against the hinder part of the body of the sphenoid bone. It is nearly of a square shape, though it is rather wider from side to side, in which direction it measures about an inch and a half.

surfaces

The anterior surface is convex and prominent on each side, but marked along the middle line by a groove in which the basilar artery lies. By the opposite surface the pons forms the part of the floor of the fourth ventricle.

borders,

The upper border is the longer, and arches over the crura cerebri. The lower border is nearly straight, and projects above the medulla

and sides.

oblongata. On each side the pons is continued into the middle peduncle of the cerebellum, and the fifth nerve issues through it on each side.

It consists of ventral

STRUCTURE. The ventral or anterior half of the pons consists of transverse fibres which are in part of their extent divided into two layers by the prolongation upwards through them of the fibres of the

and dorsal portions.

pyramids of the medulla oblongata. The dorsal or posterior half is a continuation of the reticular formation, with the grey layer of the floor of the fourth ventricle, from the medulla oblongata.

Dissection to expose the fibres.

Dissection. The superficial transverse fibres of the pons have

already been divided along the line of the pyramid of the right side (fig. 263, p. 734) and turned outwards so as to denude the longitudinal fibres (*c*) of that body ; and this set of longitudinal fibres, having been cut across already in the medulla oblongata, may be raised as far as the upper border of the pons. Beneath them will appear the second or deep set of transverse fibres of the pons (fig. 264 *f*, p. 735).

The deep transverse fibres may next be cut through outside the pyramidal tract (fig. 264), and the reticular formation will then be

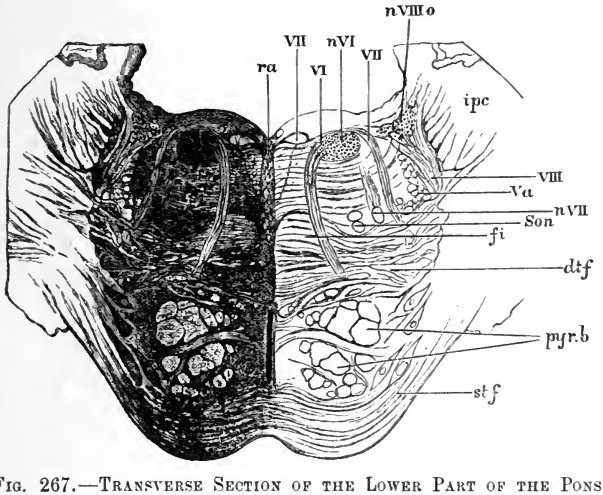


Fig. 267.—Transverse Section of the Lower Part of the Pons (after Obersteiner).

ra. Raphé.
ipc. Inferior peduncle of cerebellum.
stf. Superficial transverse fibres.
pyr.b. Pyramidal bundles.
dtf. Deep transverse fibres.
fi. Fillet.
Son. Superior olivary nucleus.
Va. Ascending root of fifth nerve.
VI. Sixth nerve.
nVI. Its nucleus.
VII. Seventh nerve.
nVII. Its nucleus.
VIII. Upper root of auditory nerve.
nVIIIo. Outer auditory (dorsal vestibular) nucleus.

seen, in which deep longitudinal fibres ascend from the medulla oblongata (*d*).

Transverse fibres of ventral portion.

The *transverse fibres* of the ventral portion of the pons pass into the middle peduncle of the cerebellum. They are mostly collected into two layers, superficial and deep (fig. 266), which enclose the longitudinal fibres of the pyramid; but some transverse fibres pass between the bundles of the pyramidal tract. The superficial fibres are nearly horizontal in the lower part of the pons, but the upper ones descend to join the cerebellar peduncle, and some are seen on the surface crossing obliquely over the lower fibres. It will be found, however, that the same bundles of transverse fibres cannot be traced across in the pons from one side of the cerebellum to the

other, but that they break off near the middle line and mostly assume a longitudinal direction. They are in great part connected with pontine cells which are associated with fibres descending in the crusta of the crus cerebri of the opposite side.

Pyramidal tract in pons.

The *pyramidal fibres* (fig. 266, 267, *pyr. b*) enter the pons below as a single mass, but in their passage upwards through the pons they are broken up by decussating bundles of transverse fibres. Much increased in number, they emerge at the upper border of the pons, and are continued into the lower portion (crusta) of the crus cerebri.

Grey matter in transverse fibres.

Scattered amongst the transverse fibres are numerous small masses of grey matter (nuclei pontis), with which the cerebellar fibres are connected, as just explained.

Formatio reticularis.

The *reticular formation* of the pons (fig. 266) is formed of longitudinal fibres continued from the medulla oblongata and passing upwards to the upper portion (tegmentum) of the crus cerebri and decussating with various transverse fibres. It contains much interspersed grey matter; and near the floor of the fourth ventricle there are several nerve-nuclei, which will be referred to when that cavity is described.

Raphé.

In the dorsal portion of the pons, as in the medulla oblongata, there is a median *raphé* (fig. 267, *ra*), formed mainly by the transverse fibres changing their direction as they cross the middle line.

Superior olive.

There is also in the lower part of the pons, close behind the deep transverse fibres of the ventral portion, and occupying a position immediately above the olivary body, a small collection of grey matter to which the name of *superior olivary nucleus* is given (fig. 267, *Son*), and which is connected with some of the fibres coming from the cochlear portion of the auditory nerve.

Section IV.

DISSECTION OF THE CEREBRUM.

Situation of the cerebrum.

The CEREBRUM, or great brain, the largest of the subdivisions of the encephalon, fills the upper part of the cranial cavity, and occupies the anterior and middle fossæ of the base of the skull. Its hinder part rests on the tentorium, which separates it from the cerebellum.

Lower limit

Its lower limit would be indicated *on the surface of the head* by a line carried along the eyebrow to the external angular process of the frontal bone and then descending to the upper border of the zygoma and continued backwards to the external occipital protuberance.

Form.

Taking the general form of the cranial cavity, the cerebrum is convex on the upper aspect, and uneven on the lower. It consists

Two hemispheres.

of two hemispheres, which are placed side by side, and separated by a median longitudinal fissure above as far down as the great transverse

commissure—the *corpus callosum*. In their lower half the hemispheres are united by other commissures, as well as by several connecting parts at the under surface. The under part of each hemisphere is divided into two by the deep transverse cleft—the *fissure of Sylvius*. united by median parts.

UNDER SURFACE, OR BASE, OF THE CEREBRUM (fig. 268). The Under surface of cerebrum

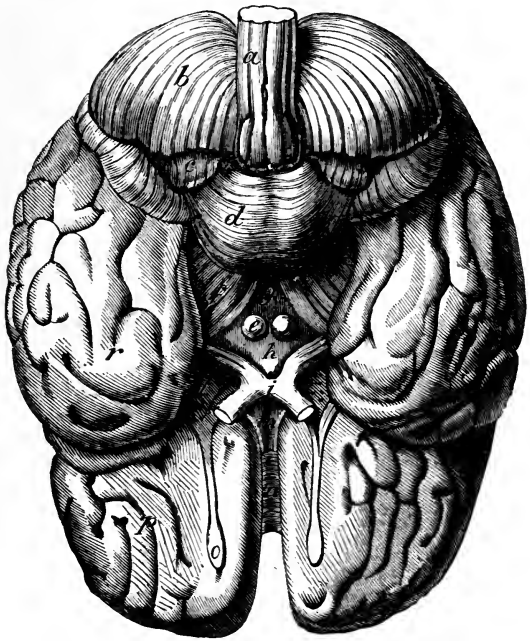


FIG. 268.—UNDER SURFACE OF THE BRAIN.

a. Medulla oblongata.
b. Hemisphere of cerebellum.
c. Flocculus.
d. Pons.
e. Corpus albicans.
f. Crus cerebri.
g. Posterior perforated space.
h. Tuber cinereum.
i. Optic commissure.
l. Vallecula Sylvii and anterior perforated space.
m. Lamina cinerea.
n. Rostrum of corpus callosum : on each side of *m*, is a narrow white band—the peduncle of the corpus callosum.
o. Olfactory bulb.
p. Frontal lobe of the cerebral hemisphere.
r. Temporal, separated from the foregoing by the fissure of Sylvius.

under surface of the cerebrum is irregular, in consequence of its fitting into inequalities in the base of the skull ; and on this aspect the separation into hemisphere is not so complete as on the upper. The main objects to be recognised along the median part of the base of the brain have already been enumerated (pp. 725 and 726).

The PEDUNCLE OF THE CEREBRUM OR CRUS CEREBRI (*f*). This is a large, white, stalk-like body, which reaches from the upper border Crus cerebri.

of the pons to the under part of the cerebral hemisphere of the same side, near the inner margin. In the natural position the two peduncles occupy the opening in the tentorium cerebelli. Each is about three-quarters of an inch long, and widens as it approaches the cerebrum. Crossing its lower surface is the optic tract; and between the crura of opposite sides is the *interpeduncular space*, which contains the posterior perforated space, the corpora albicantia, and the tuber cinereum with the infundibulum.

Composed of three parts.

Structure. The peduncle consists of a superficial (lower) layer of white fibres, the *crusta*, continued from the longitudinal fibres of the pons, a prolongation of the reticular formation and of other parts termed the *tegmentum*, and an intermediate stratum of grey matter—the *substantia nigra*.

Dissection of the crus cerebri.

Dissection. For the present, the main constituents of the crus cerebri may be made out; but various accessory parts will be referred to later. If the students are working with two brains, the cut surface of the crura should be examined on the preparation in which the pons and cerebellum have been removed, the fibres of the crusta should be dissected forwards to their entry to the cerebrum and sections should be made of the tegmentum as far forwards as through the anterior corpus quadrigeminum. If only one brain is used the right crus only should be examined. The optic tract should be divided, and the fibres continuous with the pyramid of the medulla oblongata should be raised as far as the junction of the crus with the hemisphere. In this proceeding the substantia nigra (fig. 264, *g*) will appear; and beneath it will be seen the tegmentum. Finally a block of this crus should be removed beneath the quadrigeminal bodies, but leaving them behind, taking care not to transgress the middle line into the left crus.

Crusta.

The *crusta* (fig. 269) is composed of coarse bundles of white fibres, ascending from the pons to the cerebral hemisphere, where they enter a layer of white fibres termed the internal capsule, which will be subsequently seen. The continuation of the pyramidal fibres of the medulla oblongata (pyramidal tract) occupies the central part only of the crusta; and the lateral parts consist of fibres which have already been traced into the pons. Those on the inner side of the crusta pass from the frontal lobe of the hemisphere, the outer ones from the occipital and temporal lobes, whilst fibres from the fronto-parietal regions, with the pyramidal tract, occupy the intermediate station.

Substantia nigra.

The *substantia nigra* (fig. 269) is a layer of dark grey matter which separates the crusta from the tegmentum. In transverse sections it is seen to be convex towards the crusta, and thicker at the inner than at the outer side.

Tegmentum.

The *tegmentum* is united internally with the like structure of the opposite side below; but higher up, the two are separated by the grey matter of the posterior perforated space. It consists of a recticular formation continuous with that of the pons, together with a considerable bundle of fibres derived from the cerebellum (superior

peduncle of the cerebellum), in connection with which a roundish mass of grey substance named the *nucleus of the tegmentum* or *red nucleus* (fig. 283, p. 775) may be seen on transverse section of the fore part. Above, the tegmentum joins the under surface of the optic thalamus. Red nucleus.

Between the tegmentum and the substantia nigra will be seen, on section, an intermediate greyish layer known as the *stratum intermedium*, and above this, and along the outer margin of the tegmentum in the region of the inferior quadrigeminal body, will be seen a whitish band, *the fillet* (fig. 269). Stratum intermedium.

The POSTERIOR PERFORATED SPACE (fig. 268, *g*) is situate in the depression between the crura cerebri. The bottom of this hollow is formed by a layer of grey matter, which is perforated by the central branches of the posterior cerebral arteries. This structure forms the hinder part of the floor of the third ventricle. Posterior perforated spot.

The CORPORA ALBICANTIA (corp. mamillaria; *e*) are two round white bodies, about the size of small peas, which are constructed in Corpora albicantia.

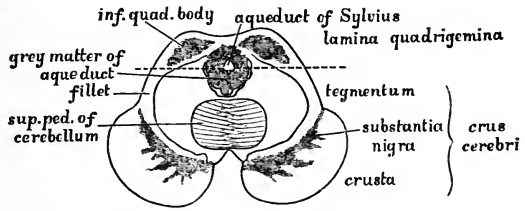


FIG. 269.—TRANSVERSE SECTION OF THE CRURI CEREBRI THROUGH THE SUPERIOR CORPUS QUADRIGEMINUM.

greater part by the crura of the fornix. If one, say the right, is cut across, it will be seen to contain grey matter.

The TUBER CINEREUM (*h*) is a portion of the thin grey layer forming the floor of the third ventricle, which is continuous behind with the grey matter of the posterior perforated space, and in front, above the optic commissure, with the lamina cinerea. It is convex on the surface, and is prolonged at its fore part into the following body. Tuber cinereum

The INFUNDIBULUM is a funnel-shaped tube which reaches from the tuber cinereum to the posterior lobe of the pituitary body. It consists of a layer of grey matter; and its cavity is a part of the third ventricle. In the fœtus this tube is open between the third ventricle and the pituitary body, but in the adult it is closed below. and infundibulum.

The PITUITARY BODY will be very imperfectly seen when it has been dislodged from its resting place: it should therefore be examined when opportunity offers in the base of the skull by removing the surrounding bone. Pituitary body:

It is situate in the hollow of the sella Turcica on the sphenoid bone, and consists of two lobes, anterior and posterior. The anterior is the larger, and is hollowed out behind, where it receives the round posterior lobe. In the adult this body is solid and firm in texture; situation; two lobes.

but in the fœtus it is hollow, and the posterior lobe opens into the third ventricle through the infundibulum.

Dissection. **Dissection.** To see the lamina cinerea and the anterior end of the corpus callosum, the hemispheres are to be gently separated from each other in front.

Grey lamina. The LAMINA CINEREA (fig. 268, *m*) is a thin concave layer of grey substance, which gradually tapers upwards from the tuber cinereum to the termination of the corpus callosum. This stratum closes the anterior part of the third ventricle between the two central hemispheres, and is continuous laterally with the anterior perforated space. In consequence of its great thinness, this structure is often broken through in removing the brain.

Corpus callosum ends below in two bands, and extends into hemisphere. The CORPUS CALLOSUM (*n*), bent downwards in front, is continued horizontally backwards in the longitudinal fissure to the lamina cinerea, and ends by two white narrow bands—the *peduncles of the corpus callosum* (or *sub-callosal convolutions*), which are continued along the edge of the lamina cinerea on each side to the anterior perforated spot. The anterior bend of the corpus callosum is known as the *genu* (fig. 274, p. 757), and the recurved portion is known as the *rostrum;* but this, with the other parts of the corpus callosum, will be seen to more advantage later.

Vallecula Sylvii. VALLECULA SYLVII AND ANTERIOR PERFORATED SPACE. The vallecula Sylvii is a depression between the optic commissure and the fore part of the temporal lobe of the hemisphere, which lodges the upper end of the internal carotid artery. Externally it leads into the Sylvian fissure, and in front it is bounded by the diverging roots of the olfactory tract. The floor of the fossa is formed by a layer of grey matter which is perforated by the central branches of the anterior and middle cerebral arteries, thus giving rise to its name as the *anterior perforated space.*

Anterior perforated space.

Olfactory lobe lies in olfactory sulcus. The OLFACTORY LOBE consists of an elongated nerve-like part which is named the *olfactory tract,* and a terminal expansion in front —the *olfactory bulb.* It lies in a groove (olfactory sulcus; fig. 272, p. 750, *ol*) on the surface of the inner orbital convolution of the frontal lobe of the hemisphere.

Olfactory bulb. The *olfactory bulb* (fig. 268, *o*) is an oval mass, of a greyish colour, and nearly half an inch in length, which rests on the cribriform plate of the ethmoid bone. From its under surface the olfactory nerves arise.

Olfactory tract: roots, outer and inner. The *olfactory tract* is a prismatic band, about an inch long, the upper edge of which is received into the olfactory sulcus. It is attached by its base, where it is somewhat expanded, to the frontal lobe close in front of the anterior perforated space; and from this part two diverging white streaks, the *inner* and *outer olfactory roots,* proceed to neighbouring convolutions. The external root passes along the outer margin of the anterior perforated space, and across the beginning of the Sylvian fissure, to the anterior extremity of the temporal lobe. The internal root, not always visible, bends inwards, and joins the lower end of the subcallosal convolution. By raising

the olfactory lobe from its sulcus, the dorsal ridge will be seen to become enlarged at its posterior end, forming the *olfactory tubercle.* Olfactory tubercle.

Position of the part. Now that the base of the cerebrum has been studied, the brain should be turned over for the examination of the upper part. Something should then be placed beneath the fore part, in order that it may be raised to the same level as the back; and a rolled-up cloth should loosely encircle the whole, to support the hemispheres. Position f brain to examine upper part.

THE FISSURES, SULCI AND CONVOLUTIONS OF THE CEREBRAL HEMISPHERE.

Upper Surface of the Cerebrum. Viewed from above, the cerebrum is ovoidal in form, and the upper surface is convex in accordance with the shape of the skull. Cerebrum is convex above, and

A *median longitudinal fissure* divides it incompletely into halves. At the front and back the hemispheres are quite separated by it; but at the middle and under parts they are united by connecting bodies, the largest of which is the white corpus callosum. The falx cerebri is lodged in the fissure. divided into two by a median fissure.

Each hemisphere is larger in front than behind, although the greatest breadth is placed behind the middle. Its outer surface is convex and applied to the skull, and the inner is flat and rests against the falx cerebri. The surface of the hemisphere consists of grey matter (cortex of the cerebrum), and is marked by tortuous eminences separated by grooves. The eminences are named *convolutions* or *gyri;* the grooves are either *fissures* or *sulci.* Hemisphere grey on surface, marked by convolutions and furrows.

The *grooves are of two kinds.* The greater number are superficial depressions which carry inwards the grey cortex and only indent the central white substance, and are called *sulci;* a few, however, penetrate more deeply, and are the result of folds involving the whole thickness of both grey and white substance of the hemisphere, so as to affect the form of the cavity (lateral ventricle) contained within or to give rise to eminences projecting on its wall. These hollows are distinguished as *fissures.* Furrows are incomplete and complete.

The convolutions and sulci, especially the smaller ones, vary in different brains, and they are not exactly alike even in the two hemispheres of the same cerebrum. Their general arrangement or plan is, however, sufficiently constant, and there will seldom be much difficulty in recognising the several parts referred to in the following description. Convolutions vary, but plan is uniform.

Interlobar Sulci and Lobes of the Hemisphere. The outer surface of the hemisphere is divided into regions, or groups of convolutions, known as the *lobes* of the cerebrum, by means of some of the most constant fissures or sulci, aided by lines prolonged from these. The interlobar sulci are three in number, viz.:— Division of the hemisphere.

The *fissure of Sylvius* (fig. 270, *s*) begins at the vallecula Sylvii, whence it extends transversely outwards across the under surface of the hemisphere, separating the frontal and temporal lobes. Sylvian fissure

has three branches.

As soon as it reaches the outer surface, it gives off one small branch forwards, *the anterior limb* (fig. 270, *s'*), and another upwards, *the ascending limb* (*s''*), which project into the inferior frontal convolution,

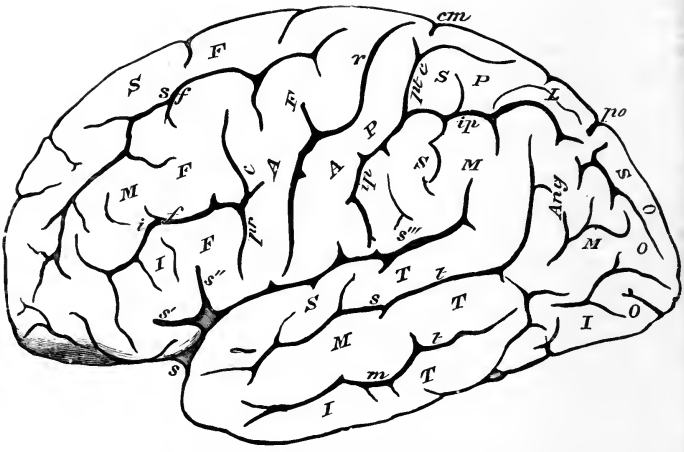


FIG. 270.— SULCI AND CONVOLUTIONS OF THE OUTER SURFACE OF THE HEMISPHERE.

Fissures and Sulci.

s. Fissure of Sylvius; *s'*, its anterior, *s''* its ascending, and *s'''*, its posterior branch.
r. Sulcus of Rolando.
po. Parieto-occipital fissure.
sf. Superior, and
if. Inferior frontal sulcus.
pr.c. Præcentral sulcus.
ip. Intraparietal.
pt. c. Postcentral (superior).
cm. End of calloso-marginal sulcus.
s'. First temporal or parallel sulcus, and
mt. Second temporal sulcus.

Convolutions:

SF. Superior.
MF. Middle, and
IF. Inferior frontal.
AF. Ascending frontal.
AP. Ascending parietal.
SPL. Superior parietal lobule.
S.M. Supramarginal convolution.
Ang. Angular.
SO. Superior.
MO. Middle, and
IO. Inferior occipital.
ST. First.
MT. Second, and
IT. Third temporal.

Note.—The inferior parietal lobule is commonly described as consisting of these parts:—

1. The *supra-marginal* surrounding the upturned end of the fissure of Sylvius.
2. The *angular* surrounding the upturned end of the first temporal sulcus.
3. The *postparietal* surrounding the upturned end of the second temporal sulcus.

Only the first two of these are represented on the figure. The upturned, posterior, part of the second temporal sulcus is often separate from the anterior part.

and then continues backwards as the *posterior limb* (*s'''*) through about the middle third of the hemisphere. The posterior limb separates the temporal from the frontal and parietal lobes; it ascends

somewhat as it runs backwards; and at its termination it is bent upwards for a short distance and projects into the parietal lobe.

When the brain is in the skull, the place of division of the fissure of Sylvius is opposite the articulation of the great wing of the sphenoid with the parietal bone; or opposite a point one and a quarter inches behind the external angular process of the frontal bone and quarter of an inch above the level of that process *on the undissected head.* Position in relation to bones of head.

The *sulcus of Rolando* (central sulcus; fig. 270, *r*) crosses the outer surface of the hemisphere near the middle. Beginning above close to the margin of the great longitudinal fissure, the furrow runs downwards and somewhat forwards, with a serpentine course, to end about one inch behind the place of division of the Sylvian fissure, and very near to its posterior limb. This sulcus separates the frontal from the parietal lobe. Sulcus of Rolando

The upper end of the furrow of Rolando is placed from an inch-and-a-half to two inches behind the coronal suture, and the lower end about one inch. *In the undissected head* its upper end is half an inch behind a point midway between the glabella and the external occipital protuberance, measured along the convexity of the skull, and the general direction of the sulcus is downwards and forwards towards the mid-point of the zygoma. is behind coronal suture.

The *parieto-occipital fissure* (fig. 270 and fig. 273, p. 753, *po*) is a deep hollow at the hinder part of the inner surface of the hemisphere. Its upper end appears on the superior surface of the cerebrum about midway between the sulcus of Rolando and the posterior extremity of the hemisphere, and extends outwards for nearly an inch from the margin of the longitudinal fissure. It indicates the anterior limit of the occipital lobe. The part on the mesial surface of the hemisphere is often called the *internal*, and that on the outer surface the *external parieto-occipital fissure.* Parieto-occipital fissure;

The fissure is placed opposite the summit of the lambdoid suture. situation.

Lobes. The outer surface of the hemisphere is divided into five lobes (excluding the olfactory) which have the following names and limits:— Lobes of hemisphere.

The *frontal lobe* forms the anterior half of the hemisphere. It is limited below by the posterior branch of the fissure of Sylvius (fig. 270, *s'''*), and behind by the sulcus of Rolando (*r*). Its under part, which rests on the roof of the orbit, is named the *orbital lobule.* Frontal lobe is largest: orbital lobule.

The *parietal lobe* is little more than half the size of the frontal. Its anterior limit is the sulcus of Rolando (*r*), and its posterior a line drawn transversely over the hemisphere from the parieto-occipital fissure. Below, it is bounded in its fore part by the posterior branch of the fissure of Sylvius (*s'''*), and in its hinder part by a line extending backwards from the spot where this fissure turns upwards to the line drawn transversely outwards from the parieto-occipital fissure. This limitation of the lobe is quite arbitrary and can be used only for descriptive purposes, since its Parietal lobe: boundaries are in great part artificial.

convolutions are continuous with those of the occipital lobe behind, and of the temporal lobe below.

Occipital lobe.

The *occipital lobe* is small, and triangular in shape. It is separated from the parietal lobe for a short distance above by the parieto-occipital fissure (*po*); but its anterior boundary is for the most part artificial, being constituted by the line just mentioned, continuing the direction of that fissure across the outer surface of the hemisphere. Its convolutions join those of the parietal and temporal lobes.

Temporal lobe.

The *temporal lobe* projects into the middle fossa of the base of the skull. Its fore part is separated from the frontal and parietal lobes by the fissure of Sylvius, but its hinder part is only limited by the lines above mentioned, across which its convolutions pass into those of the parietal and occipital lobes.

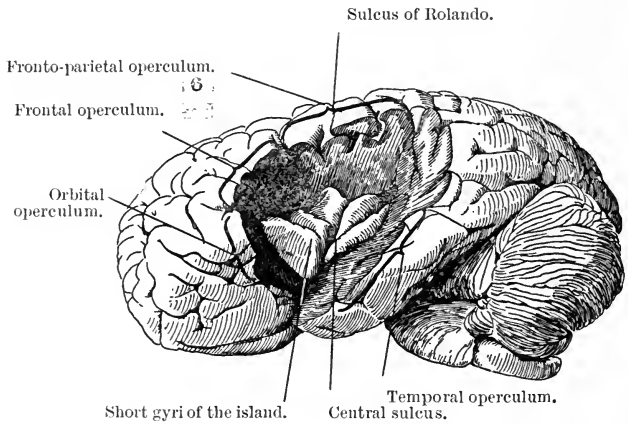


FIG. 271.—THE ISLAND OF REIL, SHOWING WHERE THE OPERCULA HAVE BEEN CUT AWAY.

Other convolutions of this lobe will be seen on the under surface of the hemisphere.

Central lobe, or island of Reil,

The *central lobe*, insula, or island of Reil (fig. 271), is placed at the bottom of the fissure of Sylvius, and is concealed by the overlapping of the temporal, parietal and frontal lobes. If the margins of the Sylvian fissure be drawn asunder, the island will be seen to have a triangular form, with the apex directed downwards towards the anterior perforated space, and to be bounded by three furrows (the *sulci of Reil*), one in front, one above, and another behind; the hinder one being continuous with the posterior branch of the fissure of Sylvius. The central lobe is placed opposite the lenticular muscles of the corpus striatum in the interior of the hemisphere.

surrounded by three sulci of Reil.

Opercula of the insula;

The portions of the frontal, parietal and temporal lobes which overhang, and conceal, the island are called *opercula of the insula*. These opercula have been cut away to expose the island in fig. 271,

but the whereabouts of each is indicated. (Compare figs. 270 and 272).

The opercula are called (1) orbital, (2) frontal, (3) fronto-parietal, and (4) temporal.

orbital, 1. The *orbital operculum* is the back part of the posterior orbital convolution (P.O., fig. 272) of the frontal lobe which conceals the front part of the island.

frontal, 2. The *frontal operculum* is the overhanging piece of the frontal lobe between the anterior and ascending limbs of the Sylvian fissure.

fronto-parietal, 3. The *fronto-parietal operculum* is the part belonging to the frontal and parietal lobes that overlaps the island behind the ascending limb of the fissure of Sylvius.

temporal. 4. The *temporal operculum* is the projecting anterior part of the temporal lobe.

SULCI AND CONVOLUTIONS OF THE FRONTAL LOBE. On the outer surface of the frontal lobe there are four convolutions, separated by three sulci.

Frontal sulci are one transverse, and two longitudinal. The *præcentral sulcus* (fig. 270, *pr c*) is placed in front of, and nearly parallel to, the lower half of the sulcus of Rolando. From it the *inferior frontal sulcus* (*if*) runs forwards and downwards, towards the orbital surface of the lobe. Above this, the *superior frontal sulcus* (*sf*), which is often interrupted once or twice by cross gyri, takes a similar course.

Frontal convolutions: transverse; The *ascending frontal convolution* (AF) is simple, and forms the hindmost part of the frontal lobe, extending from the upper margin of the hemisphere to the Sylvian fissure, along the front of the furrow of Rolando. From its fore part the three longitudinal convolutions of this lobe take their origin.

superior, The *superior frontal convolution* (SF) is longer and broader than the others, and is commonly subdivided by a special *sulcus paramedialis* into secondary gyri. It lies between the margin of the hemisphere and the upper frontal sulcus.

middle, The *middle frontal convolution* (MF) runs from the ascending frontal to the lower margin of the lobe, between the upper and lower frontal sulci. Like the superior frontal convolution, it is also often subdivided into upper and lower parts by a sulcus (*sulcus frontalis medius*, Eberstaller) running along it.

and inferior longitudinal. The *inferior frontal convolution* (IF) is the smallest of all. Springing from the lower end of the ascending frontal convolution, it arches round the ascending and anterior branches of the Sylvian fissure, and passes into the posterior orbital gyrus. It is sometimes described as consisting of three parts :—

Three parts of the inferior :

pars basilaris, 1. *pars basilaris*, between the ascending limb of the fissure of Sylvius and the inferior part of the præcentral sulcus.

pars triangularis, 2. *pars triangularis*, between the ascending and anterior limbs of the Sylvian fissure, being only another name for the frontal operculum ; and

pars orbitalis. 3. the *pars orbitalis*, the part below the anterior limb of the fissure of Sylvius

Orbital sulcus and gyri.

Orbital lobule (fig. 272). The orbital lobule is subdivided by a Y- or H-shaped *orbital sulcus* (orb) into three convolutions, named *internal* (IO), *anterior* (AO), and *posterior* (PO), *orbital*, which are the continuation respectively of the superior, middle, and inferior frontal convolutions. On the internal orbital convolution is a longitudinal groove—*olfactory sulcus* (ol), for the reception of the olfactory lobe.

Olfactory sulcus.

Parietal sulci are

intraparietal,

which has ascending and horizontal parts.

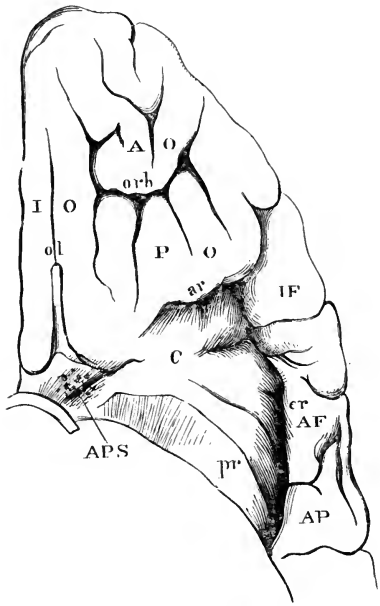


FIG. 272.—ORBITAL LOBULE AND ISLAND OF REIL.

orb. Orbital sulcus.

ol. Olfactory sulcus.

ar. Anterior, er. Superior, and pr. Posterior sulci of Reil, the last opened by the removal of the temporal lobe.

IO. Internal, AO. Anterior, and PO. Posterior orbital convolutions.

C. Central lobe or island of Reil.

IF, AF, and AP. Lower parts of the inferior frontal, ascending frontal, and ascending parietal gyri, constituting opercula.

APS. Anterior perforated space.

SULCI AND CONVOLUTIONS OF THE PARIETAL LOBE. In the parietal lobe there are two named sulci; and four convolutions are distinguished.

The *intraparietal sulcus* (fig. 270, *ip*) begins close to the posterior branch of the fissure of Sylvius, about midway between the upturned extremity of this and the lower end of the sulcus of Rolando. It first ascends, running nearly parallel to the lower half of the latter sulcus, and then is directed backwards to the hinder limit of the parietal lobe, where it often becomes continuous with the superior occipital sulcus. Commonly, also, it ends in a forked manner in a sulcus, (*anterior occipital*), which passes from above downwards at the front of the occipital lobe. The upper, or horizontal, part of the intraparietal sulcus is frequently interrupted by one or two cross gyri. The lower, or vertical part, is often distinguished as the *inferior postcentral* sulcus, and is mostly continuous with the following one.

and postcentral.

The *superior postcentral sulcus* (*ptc*) continues the direction of the ascending part of the intraparietal sulcus, and ascends behind the upper half of the furrow of Rolando. It generally opens into the intraparietal sulcus at the spot where the latter is directed backwards.

Convolutions: ascending parietal

The *ascending parietal convolution* (AP) is placed opposite the

ascending frontal, and like that is simple, and extends from the upper margin of the hemisphere to the posterior branch of the Sylvian fissure. In front of it is the furrow of Rolando, round the ends of which it joins the ascending frontal convolution. Behind, it is limited by the superior postcentral sulcus above, and the ascending part of the intraparietal, or the inferior postcentral sulcus below.

superior parietal lobule,

Parietal lobules. The larger portion of the parietal lobe behind the ascending parietal convolution is divided into two parietal lobules by the horizontal part of the intraparietal sulcus. The *superior parietal lobule* (SPL) is connected in front to the upper end of the ascending parietal convolution between the postcentral sulcus and the upper margin of the hemisphere, and behind to the upper occipital convolution by a small winding gyrus which is called the first or *superior parieto-occipital annectant convolution* (below *po*). This lobule is divided into several secondary gyri.

and inferior parietal lobule, consisting of supra-marginal,

The *inferior parietal lobule* is again subdivided into two, or sometimes three, convolutions, but the separation between them is often very indistinct. The *supramarginal convolution* (SM) is the anterior and larger of these; it springs in front from the lower end of the ascending parietal convolution, encircles the extremity of the posterior branch of the Sylvian fissure, and ends by joining the first temporal convolution.

angular,

The *angular convolution* (*Ang*) arises from the hinder part of the foregoing, arches over the upper end of the first temporal sulcus (*st*) and descends behind that furrow to be continued into the second temporal convolution.

and post-parietal convolutions.

A third part of the inferior parietal lobule may also be distinguished, but it is not indicated in fig. 270. It is called the *post-parietal convolution*, and is continuous with the angular convolution in front. It arches over the up-turned end of the second temporal sulcus, in front of which it is continuous with the second and behind with the third temporal convolution. Posteriorly also it is continued into the occipital lobe and forms the *inferior parieto-occipital annectant convolution*. The posterior part of the second temporal sulcus, which it embraces, is often separate from the anterior part of that sulcus, and can only be distinguished from the latter by the fact that it continues the direction of the furrow backwards and upwards.

Occipital sulci and convolutions are superior, middle, and inferior.

SULCI AND CONVOLUTIONS OF THE OCCIPITAL LOBE. The occipital lobe is divided into three convolutions, which run forwards from the posterior extremity of the hemisphere, by two small furrows—the *superior* and *middle occipital sulci*. The *superior occipital convolution* (SO) is united anteriorly to the superior parietal lobule by the superior annectant gyrus; the *middle* (MO) to the post-parietal convolution by the inferior, and the *inferior* (IO) to the third temporal convolution by the occipito-temporal annectant gyrus. An inconstant *inferior occipital sulcus*, at the lower margin of the hemisphere, separates the third occipital convolution from the temporal lobe on the under surface. The occipital convolutions are very variable, and the sulci are frequently ill marked.

Annectant convolutions.

Temporal sulci:

SULCI AND CONVOLUTIONS OF THE OUTER SURFACE OF THE TEMPORAL LOBE (fig. 270). There are five convolutions of this lobe; the first, second and a part of the third, with their intervening sulci, are seen on the outer surface and the remainder on the under aspect of the cerebral hemisphere.

first or parallel,

The *first temporal* or *parallel sulcus* (*st*) is well marked, and runs below and parallel to the posterior branch of the fissure of Sylvius, from near the anterior extremity of the lobe, backwards and

second, and

upwards, into the inferior parietal lobule. The *second temporal sulcus* (*mt*) takes a similar course at a lower level, but it is not so

third.

constant as the superior; and the third (fig. 273, *it*), which is also very variable, is placed on the under surface of the hemisphere near the margin, separating the third from the fourth convolution.

Convolutions.

The *first temporal convolution* (inframarginal; fig. 270, ST) forms the lower boundary of the posterior branch of the Sylvian fissure, and is continuous behind with the supramarginal convolution. The *second* and *third temporal convolutions* (MT and IT) are commonly united in some part of their extent. The posterior end of the second one is joined by the angular and post-parietal gyri. The third forms the lower margin of the lobe and joins the post-parietal and lowest occipital gyri.

Convolutions, of island of Reil.

CONVOLUTIONS OF THE CENTRAL LOBE (figs. 271 and 272, C). The surface of the insula is divided by an oblique furrow—the *central sulcus of the insula*, placed opposite the lower end of the furrow of Rolando, into an anterior triangular, and a posterior more elongated portion. The anterior part is again subdivided externally into three small *gyri breves*, and the posterior part into two *gyri longi*.

Sulci and convolutions of inner and tentorial surfaces.

SULCI AND CONVOLUTIONS OF THE INNER SURFACE OF THE HEMISPHERE (fig. 273). The convolutions of the inner aspect of the hemisphere, with which are included those of the lower surface behind the fissure of Sylvius, are generally well defined; but some being so long as to reach beyond the extent of a single lobe of the outer surface, they are not usually like those described as forming lobes.

How to see them.

Dissection. The parts to be now described can only be seen satisfactorily on a separate hemisphere, and if the students are working with two brains, one of the hemispheres on that brain in which the cerebellum and other parts have been removed, should be used by separating it from its fellow by a mesial incision. If, however, the student possesses only the one brain, he may show much of the inner surface by cutting off the left hemisphere as low as the corpus callosum and examining the right side and the under surface of the left.

Calloso-marginal sulcus.

SULCI. The *calloso-marginal sulcus* (*cm*) begins below the rostrum of the corpus callosum, and arches upwards, following the curve of the fore part of that body. It is then directed backwards as far as the posterior extremity of the corpus callosum, where it bends upwards and ends by notching the superior margin of the hemisphere (fig. 270, *cm*). Its fore part is frequently interrupted by

one or two small gyri uniting the adjacent convolutions. Some distance before its posterior termination it sends a small limb upwards, which forms the anterior limit of a convolution (para-central, fig. 273, *ov*) enclosing the upper end of the Rolandic, or central sulcus on its mesial aspect.

The *parieto-occipital* or *perpendicular fissure* (fig. 273, *po*) is a deep cleft which descends from the upper margin of the hemisphere at the back part, with a slight inclination forwards, to join the

Parieto-occipital fissure.

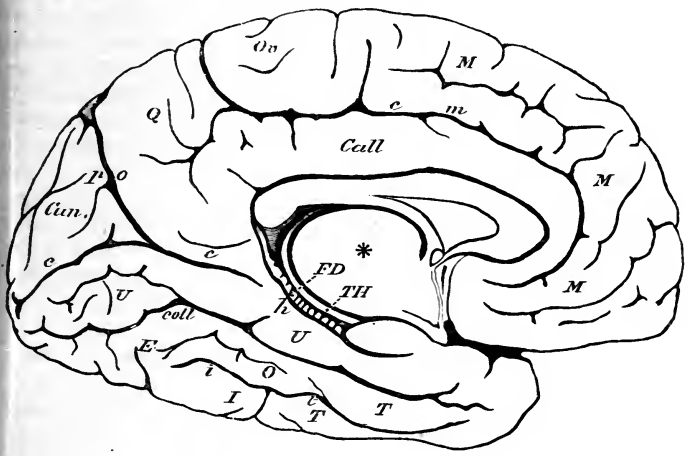


FIG. 273.—SULCI AND CONVOLUTIONS OF THE INNER ASPECT OF THE HEMISPHERE.

Fissures and Sulci:

cm. Calloso-marginal.
po. Parieto-occipital fissure.
c. Calcarine fissure.
h. Hippocampal or dentate fissure.
coll. Collateral fissure (fourth temporal hollow).
it. Third temporal sulcus.

Convolutions:

M. Marginal.
Ov. Para-central, or oval, lobule.
Call. Callosal convolution.
Q. Præcuneus or quadrate lobule.
Cun. Cuneate lobule.
U. Uncinate convolution (fifth temporal).
EOT. Fourth temporal (occipito-temporal).
IT. Third temporal.
FD. Dentate convolution or fascia dentata.
TH. Tænia hippocampi.
* Cut surface of optic thalamus.

calcarine fissure on a level with the hinder end of the corpus callosum.

The *calcarine fissure* (*c*) is nearly horizontal. It begins close to the posterior extremity of the hemisphere, and is directed forwards, receiving the parieto-occipital fissure about the middle of its length, to end a little below the splenium of the corpus callosum. It gives rise to the eminence called the *hippocampus minor* in the lateral ventricle. The posterior and anterior parts of this fissure are developed separately at first; and if the student opens up the fissure near the entrance of the parieto-occipital he will see a small

Calcarine fissure.

convolution running across its floor from the cuneate lobe (*Cun*) to the back part of the fifth temporal or uncinate convolution (U). The back part of the uncinate convolution is commonly styled the *lingual*, and the small gyrus crossing the calcarine fissure is therefore the *cuneo-lingual annectant convolution.*

Annectant convolution.

Hippocampal fissure.

The *hippocampal* or *dentate fissure* (*h*) is placed in front of the foregoing, at the inner margin of the lower portion of the hemisphere, and separates the uncinate, or hippocampal convolution (U) from the tænia hippocampi (TH), which will be revealed by gently opening up the fissure. The fissure produces the hippocampus major in the descending cornu of the lateral ventricle, and its relations will be better seen when that body is examined.

The fissure produces.

Collateral fissure.

The *collateral fissure* (*coll*) represents the fourth temporal sulcus and gives rise to the collateral eminence in the lateral ventricle. It extends from near the posterior extremity of the hemisphere to the fore part of the temporal lobe, and is frequently broken up into two or three parts by cross gyri.

Third temporal sulcus.

The *third temporal sulcus* (IT) is usually broken into two or three parts which run more or less parallel with the outer margin of the temporal lobe. The posterior extremity of the sulcus is sometimes prolonged on to the outer surface for a short distance.

Callosal sulcus,

The *callosal sulcus* is the hollow between the upper surface of the corpus callosum and the lower surface of the callosal convolution (*Call*).

Marginal convolution.

Oval lobule.

CONVOLUTIONS. The *marginal convolution* (M) occupies the space between the calloso-marginal sulcus and the border of the hemisphere. It is much subdivided, and at its posterior extremity a small portion is marked off by a short vertical furrow, and is distinguished as the *oval* or *paracentral lobule* (*Ov.*) The marginal convolution is continuous over the border of the hemisphere with the internal orbital and superior frontal convolutions, while the oval lobule is formed by the upper end of the ascending frontal and parietal convolutions.

Convolution of the corpus callosum.

The *callosal convolution* (gyrus fornicatus; *Call*) is narrower and simpler than the marginal. Beginning below the rostrum of the corpus callosum, this convolution follows the curve of that body, and turns downwards behind its posterior extremity to end in a thin part which joins the uncinate convolution (U). It is bounded in the greater part of its extent by the calloso-marginal sulcus, but behind the spot where this furrow turns upwards it is continuous with the præcuneus, or quadrate lobule (Q). Near its ending, it is limited below by the calcarine fissure. Between it and the corpus callosum is the callosal sulcus.

Præcuneus or Quadrate lobule.

The *præcuneus* or *quadrate lobule* (Q) is placed between the end of the calloso-marginal sulcus and the parieto-occipital fissure. Much subdivided by secondary furrows, it reaches the margin of the hemisphere above, where it is continuous with the superior parietal lobule; it joins the callosal convolution below.

Cuneate lobule.

The *cuneate lobule* (occipital lobule; *Cun*) is triangular in shape, the base being formed by the margin of the hemisphere. In front

of it is the parieto-occipital, and below the calcarine fissure. Small irregular sulci divide it into secondary gyri.

The *uncinate* or *fifth temporal convolution* (U) extends from the posterior extremity of the hemisphere behind to the Sylvian fissure in front, being bounded by the calcarine and hippocampal fissures above, and by the collateral fissure below. It is somewhat narrowed in the middle, where the callosal convolution joins it, and enlarged in front and behind. At its fore part is a small piece (*uncus*) bent backwards over the lower end of the dentate fissure, and from this feature the convolution derives it name. The posterior part of the convolution, that which is limited above by the calcarine fissure, is often described as the *lingual convolution.* Uncinate and lingual convolutions.

The *fourth temporal*, or *occipito-temporal*, *convolution* (EOT) lies between the collateral fissure and the third temporal sulcus (*it*). This is frequently not distinct from the *third temporal convolution*, which forms the outer margin of the temporal lobe in the greater part of its extent. Fourth temporal convolution.

At the bottom of the dentate fissure, the grey cortex of the hemisphere ends in a projecting notched margin, which is named the *fascia dentata* or the *dentate convolution* (FD). This will be better seen subsequently. Dentate gyrus.

Structure of the convolutions. Each convolution is continuous with the general mass of the hemisphere on the one side and is free on the other, where it presents a summit and lateral surfaces, which are covered by pia mater. A cross section will show it to consist of a layer of *cortical* grey substance on the surface, which is continued at the bottom of the sulci from one eminence to another, and of a white *medullary* part in the centre, which appears as a process of the large medullary mass forming the greater part of the substance of the hemisphere. On examining closely the section of a convolution in a fresh specimen, the cortex may generally be seen to consist of three grey, and of intermediate white, layers arranged alternately, covered externally by a thin white stratum, which is most marked over the fore part of the uncinate convolution. Form and structure of convolutions; grey cortical, and white medullary parts. Structure of cortex.

If a portion of the cuneate lobule be taken it will be found that the fourth layer of the cerebral cortex is particularly distinct as a white line running in the grey matter.

INTERIOR OF THE CEREBRUM.

Each cerebral hemisphere consists of white and grey substance, the white forming the larger portion of the mass (medullary centre of the hemisphere), while the grey matter is chiefly disposed in a superficial layer (cortex) which covers the medullary centre, except over the region on the inner side whence the corpus callosum issues; but at the lower part of the hemisphere there are other collections of grey matter more or less surrounded by the medullary substance. In each hemisphere is an elongated cavity, named the *lateral ventricle*, which communicates with another median space—the *third ventricle*, placed close to the base of the brain. Outline of cerebrum: medullary centre; cortical and central grey masses; ventricles.

The student will now proceed to examine the parts in the interior of the hemisphere, carrying the dissection from above downwards.

Cut down to smaller oval centre of the hemisphere.

Dissection. Supposing both hemispheres entire, the left is to be cut off to the level of the calloso-marginal sulcus. When this has been done, the surface displays a white central mass of a semi-oval shape (centrum ovale minus) sending processes into the convolutions, and surrounded by an irregular grey margin. In a fresh brain this surface would be studded with drops of blood escaping from the divided vessels.

Reflect callosal convolution.

Next, the callosal convolution is to be divided transversely about the middle, and the two pieces, taken in the fingers, are to be thrown backwards and forwards. On its under surface will be seen a thin

Cingulum.

band of white fibres, the *cingulum* or *covered band of Reil*, which bends downwards before and behind the corpus callosum.

Repeat dissection on right side

A similar dissection is to be carried out on the opposite side; but in this case the student should insert his fingers into the calloso-marginal sulcus and *peel off the marginal convolution*, and again he should do likewise with the callosal convolution. He

to show collosal fibres.

will find that the parts tear in the direction of the central white fibres, and in this way he will obtain a good idea as to how the fibres of the corpus callosum diverge into the convolutions above its level.

Finally both hemispheres are to be removed to the level of the corpus callosum.

The larger oval centre is deeper.

Now a much larger white surface comes into view (centrum ovale majus), and the white masses in the two hemispheres are seen to be continuous, across the middle line, through the corpus callosum.

Corpus callosum:

The CORPUS CALLOSUM reaches from one half of the cerebrum to the other, and forms the roof of the lateral ventricle in each hemisphere

situation,

(fig. 279, p. 768). Its central part, which is exposed in the longi-

extent and form;

tudinal fissure, is narrow, and measures about three inches in length from before backwards. It is nearer to the anterior than to the posterior end of the cerebrum, and is somewhat arched from before backwards. On each side its upper surface is free for a short distance beneath the callosal convolution, from which it is separated by the callosal sulcus.

anterior and posterior ends;

In front, the corpus callosum is bent downwards, forming the *genu* and *rostrum*; and behind, it ends in a thickened part named the *splenium* (fig. 274).

fibres transverse;

The fibres of the corpus callosum are for the most part directed transversely, but on its upper surface there is a somewhat irregular,

a few longitudinal.

narrow longitudinal band on each side close to the middle line (the *supra-callosal convolution* or the striæ longitudinales). Between the two bands is a median groove or raphé. Farther out there may be seen other longitudinal fibres belonging to the cingulum, if that has not been completely removed. The longitudinal striæ are prolonged downwards in front, and are connected with the sub-callosal convolutions or the peduncles of the corpus callosum.

Dissection.

Dissection. In order to see the thickness of the corpus callosum, and to bring into view the parts in relation with its under surface,

a cut is to be made through it on the right side about half an inch from the middle line; and this is to be extended forwards and backwards, as far as the limits of the underlying ventricle. While cutting through the corpus callosum, the student may observe that a thin membraniform structure (ependyma) lines its under surface.

The corpus callosum is thicker at each end than at the centre, in consequence of a greater number of fibres being collected from the

Is thickened at each end;

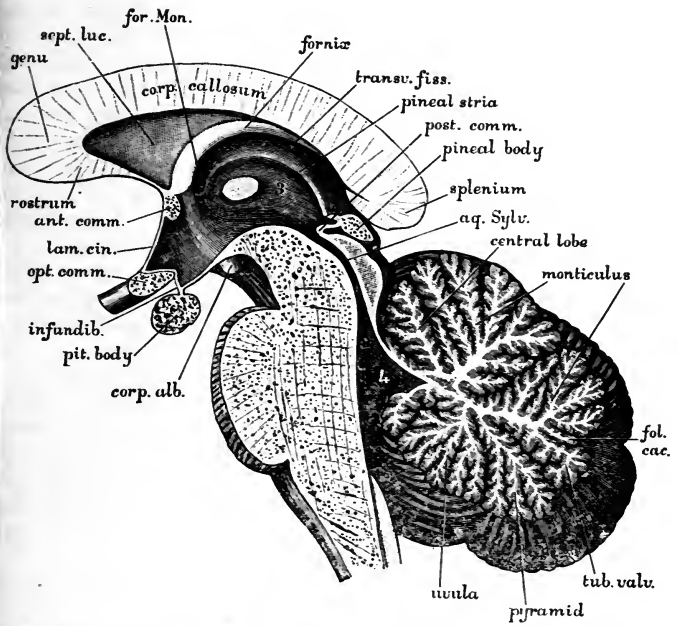


FIG. 274.—PORTION OF A MEDIAN SECTION OF THE BRAIN, SHOWING THE CORPUS CALLOSUM, THIRD (3) AND FOURTH (4) VENTRICLES, ARBOR VITÆ CEREBELLI, &c.

In front of 3, the soft commissure is seen cut across. Between the infundibulum and the corpus albicans the tuber cinereum, and behind the corpus albicans the posterior perforated space and the united tegmenta are forming the floor of the third ventricle. Above 4, is the superior medullary velum with the lingula upon it, and below are the inferior medullary velum and the nodule. The pia mater and velum interpositum are removed.

cerebrum in those positions; and the posterior part is the thickest of all. Connected with its under surface along the middle at the fore part is the septum lucidum or partition between the ventricles (fig. 274), and behind is the fornix.

under surface.

This is the chief commissural body of the halves of the cerebrum, and its fibres pass laterally into the medullary centre of the hemisphere, in which they radiate to the convolutions.

Dissection. The *left* lateral ventricle is to be now opened in the same way as the right; and to prepare for the examination of

Dissection.

the cavity on the right side, as much of the corpus callosum as forms the roof of the space is to be removed. A part of the ventricle extends down into the temporal lobe towards the base of the brain; and to open it, a cut is to be carried outwards and downwards, through the substance of the hemisphere, along the course of the hollow; and the best way to do this is to remove the parts with a scalpel, piecemeal, carefully following the descending horn of the ventricle until the parts are displayed as in fig. 275.

Brain contains five ventricles:

VENTRICLES OF THE BRAIN. Five ventricles are described in the brain; but four of them are subdivisions of one large central cavity, and these are lined throughout by a thin membrane named the *ependyma*, which is covered by epithelium, for the most part ciliated. They are the *two lateral ventricles*, one in each cerebral hemisphere, the *third ventricle* close to the base of the brain between the two hemispheres, and the *fourth ventricle* between the cerebellum and the back of the pons and medulla oblongata (fig. 274).

fifth is different from others.

The fifth ventricle is a small space between the layers of the septum lucidum, and has not any lining of ependyma (fig. 275 *b*.)

Lateral ventricle.

The LATERAL VENTRICLE (fig. 275) is a narrow space which extends nearly the whole length of the hemisphere, and sends a process downwards into the temporal lobe. The cavities of the two sides approach one another in front, where they are only separated by the thin septum lucidum; and below the hinder part of that partition, each communicates with the third ventricle by an aperture known as the foramen of Monro (fig. 274). At the back there is a wider interval between them. The roof of the space is formed in its whole extent by the fibres of the corpus callosum passing outwards to the convolutions; in the floor are numerous objects which will be enumerated in connection with the several parts of the ventricle.

Subdivision.

The ventricle consists of a central part or *body*, and three processes or *cornua*, anterior, posterior, and middle or descending.

Body;

The *body* is beneath the parietal lobe of the hemisphere, and extends from the foramen of Monro to the splenium of the corpus callosum. It is somewhat arched, with the convexity upwards, and in its floor are seen the following parts, proceeding from without

objects in floor;

inwards (fig. 275):—1, the hinder portion of a pyriform mass of grey matter forming a part of the corpus striatum (caudate nucleus; *e*), 2, a slender white band—the tænia semicircularis (*f*), 3, a narrow part of the optic thalamus (*g*), 4, a vascular fringe of the pia mater—the choroid plexus (*h*), and 5, a thin white layer—the lateral part of the fornix (*c*). It is bounded internally for a

mesial limit.

short distance in front by the hinder part of the septum lucidum (*b*), and behind this by the meeting of the fornix and corpus callosum.

Anterior horn:

The *anterior cornu* projects forwards, with an inclination downwards and outwards, into the frontal lobe. In the floor are the

boundaries.

large anterior extremity (*head*) of the caudate nucleus and the rostrum of the corpus callosum; its anterior boundary is formed by the genu of the latter body; and internally it is separated from the cavity of the opposite side by the septum lucidum.

The *posterior cornu* (*o*) is narrower and generally longer than the anterior, but its breadth and length vary much in different brains. It extends backwards into the occipital lobe, being curved outwards round the parieto-occipital fissure of the internal surface of the hemisphere. Along its inner side is an elongated white eminence —the hippocampus minor (*i*), which will be seen, on pushing the

Posterior horn: form; inner wall; and floor.

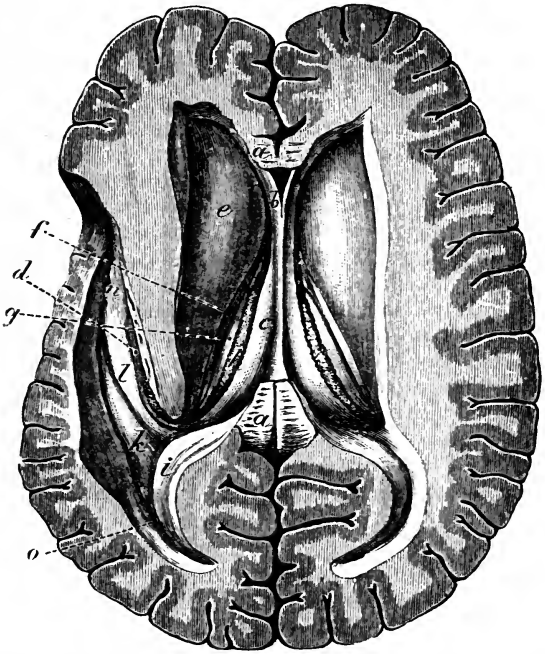


FIG. 275.—VIEW OF THE LATERAL VENTRICLES: ON THE LEFT SIDE THE DESCENDING CORNU IS LAID OPEN.

a, a. Ends of the corpus callosum.
b. Septum lucidum, enclosing the small space of the fifth ventricle.
c. Fornix.
d. Posterior pillar of the fornix or tænia hippocampi.
e. Caudate nucleus of the corpus striatum.
f. Tænia semicircularis.
g. Optic thalamus.
k. Choroid plexus.
i. Hippocampus minor.
k. Eminentia collateralis.
l. Hippocampus major.
o. Posterior cornu of the ventricle.

handle of the scalpel into the calcarine fissure, to be an infolding of the brain wall corresponding to that fissure; and the floor is formed by the hinder part of the eminentia collateralis (*k*), which, in the same manner as the preceding, represents the collateral fissure.

The *middle* or *descending cornu* leaves the hinder part of the body of the ventricle opposite the splenium of the corpus callosum, and runs downwards and forwards in the temporal lobe, describing

Middle horn: direction;

roof; a curve with the convexity outwards. *In the roof* are contained the fibres passing from the hinder end of the corpus callosum downwards and outwards into the temporal lobe, together with the prolongation of the caudate nucleus and the tænia semicircularis; and at the anterior extremity is a prominence called the amygdaloid tubercle. *The floor* is formed mainly by a long curved eminence—the hippocampus major (*l*), along the inner margin of which is a thin band prolonged from the fornix—the tænia hippocampi (*d*), while to its outer side lies the tapering fore part of the eminentia collateralis (*k*). The choroid plexus (*h*) is continued downwards along the inner side of the tænia hippocampi to the lower extremity of this cornu.

and floor.

Dissection. If the student has a separated hemisphere and opens the descending horn of the lateral ventricle as already described, he will be able, by placing the handle of the scalpel in the dentate fissure below, to demonstrate that the hippocampus major is an infolding of the brain wall corresponding to that hollow.

Septum lucidum: position, form, and attachments; The SEPTUM LUCIDUM (figs. 274, 275, *b*) is placed vertically between the two lateral ventricles, beneath the anterior half of the corpus callosum, to which its upper border is attached. It is triangular in shape, with the base turned downwards and forwards, and fixed to the rostrum of the corpus callosum. The posterior border is oblique, and joins the fornix. Its surfaces look into the lateral ventricles, opposite the head of the caudate nucleus. Although often so thin as to be translucent, the septum lucidum consists of two laminæ which enclose a space—the fifth ventricle. Each lamina is composed of white substance, with a thin layer of grey matter internally; and the ependyma of the lateral ventricle covers its outer surface.

is a double partition, containing fifth ventricle.

Dissection. **Dissection.** The fifth ventricle will be exposed by cutting through the piece of the corpus callosum which remains in the middle line, and detaching the anterior half from the septum lucidum.

Fifth ventricle. The FIFTH VENTRICLE (vent. of the septum) is a narrow slit in the fore part of the septum lucidum, where this is deeper. Posteriorly and above, the laminæ of the septum are united to a variable extent. Like the septum, it is larger in front than behind. This cavity has not any epithelial lining.

Dissection. **Dissection.** The fornix is to be next examined. To lay bare this body the posterior part of the corpus callosum should be detached with care from it, and thrown backwards; and the septum lucidum should also be removed from its upper surface.

Fornix position and form. The FORNIX (fig. 275, *c*) is a thin white layer beneath the corpus callosum, which, projecting on each side into the lateral ventricle, forms part of the floor of that cavity. Its central part or *body* is triangular in shape, with the base turned backwards; and it is continuous with the rest of the brain by processes named crura, or *pillars*, in front and behind.

Upper surface and borders. The upper surface of the body has the septum lucidum attached to it along the middle line in front; and behind, its median part

is united to the corpus callosum. Each border is free in the corresponding lateral ventricle, where it rests on the optic thalamus, the velum interpositum being between the two; and along it lies the choroid plexus. Posteriorly it joins the corpus callosum in the middle, while on each side it sends off a small riband-like band—the *posterior pillar* or *tænia hippocampi* (fig. 276, *c*, p. 763), along the concave margin of the hippocampus major. At the anterior end it is arched over the foramen of Monro, opposite the front of the optic thalamus, and ends likewise in two *anterior pillars*, which will be afterwards followed downwards to the corpora albicantia and thence into the optic thalami.

Posterior and anterior part.

If the fornix be cut across near its front, the foramen of Munro will be opened, and the descending anterior pillars will be seen (fig. 276). When the posterior part is raised (and it must be done with great care), it will be found to be supported on a process of the pia mater, named velum interpositum. Posteriorly, on the under aspect, is a triangular surface, marked by transverse lines, which are produced by the fibres of the corpus callosum appearing in the interval between the two diverging posterior pillars of the fornix: the part which is so defined has been called the *lyra* (fig. 276, *a*).

Under surface is marked by lines.

The fornix may be described as consisting of two bands, right and left, which are united for a certain distance in the central part or body. According to this view, each band, commencing in the optic thalamus and passing through the corpus albicans, arches over the foramen of Monro, and after forming the body of the fornix, is continued as the tænia hippocampi to the hook of the uncinate convolution.

Fornix formed of two bands

The FORAMEN OF MONRO (fig. 274, p. 757) is a short slit between the fore part of the fornix and the optic thalamus. Through it the lateral ventricle communicates with the third ventricle, and indirectly with the one of the opposite side. It is lined by a prolongation of the ependyma, which is thus continued from one ventricle to the other.

Foramen of Monro.

The student may leave untouched for the present the velum interpositum, and proceed to examine the bodies which have been enumerated in the floor of the posterior and descending cornua.

The HIPPOCAMPUS MINOR OR CALCAR AVIS (fig. 275, *i*) is a spindle-shaped prominence on the inner side of the posterior cornu of the lateral ventricle. If it is cut across, it will be seen to be formed by the calcarine fissure pushing outwards the wall of the cavity, and beneath the white layer is the cortical grey substance passing from the uncinate convolution to the cuneate lobule at the bottom of the fissure.

Hippocampus minor, formed by calcarine fissure.

The HIPPOCAMPUS MAJOR (figs. 275, *l*, and 276, *b*) is the large convex eminence in the floor of the descending cornu of the lateral ventricle, and, like that, is curved, with the concavity directed inwards. Its anterior extremity, which is named the *pes hippocampi*, is somewhat enlarged and presents two or three indentations, resembling the foot of a feline animal.

Hippocampus major. Pes hippocampi.

Tænia hippocampi.

Along the inner margin of the hippocampus is the *tænia hippocampi* or *fimbria* (fig. 276, *c*), which is the prolonged posterior pillar of the fornix ; this ends below by joining the recurved part of the uncinate convolution.

Dissection.

Dissection. To examine more fully the hippocampus, the hinder portions of the corpus callosum and fornix should be divided in the middle line, and the posterior part of the right hemisphere should be drawn away from the rest of the brain. When the pia mater has been removed from the inner side of the hippocampus, and this projection has been cut across, its structure will be seen.

Structure of hippocampus.

The hippocampus is covered on the ventricular surface by a thin medullary layer, with which the tænia blends. On its opposite surface is the hollow of the hippocampal, or dentate, fissure of the exterior of the brain, which is lined by grey substance. Beneath the tænia hippocampi the grey matter projects in the form of a notched ridge, the fascia dentata, or *dentate convolution*, which is external to the cavity of the ventricle (p. 755).

Collateral eminence,

The EMINENTIA COLLATERALIS (fig. 275, *k*), is the triangular, slightly convex surface occupying the floor of the posterior and descending cornua of the lateral ventricle to the outer side of the

formed by collateral fissure.

hippocampi. It lies over the collateral fissure of the under surface of the hemisphere, and its extent varies greatly in different subjects.

Amygdaloid tubercle and nucleus.

The AMYGDALOID TUBERCLE is a variable eminence due to a collection of grey matter, *amygdaloid nucleus* (fig. 279, p. 768), on the outer side of the uncus, with the cortical layer of which it is continuous.

Great transverse fissure

TRANSVERSE FISSURE OF THE CEREBRUM. By drawing the separated part of the right hemisphere away from the crus cerebri and the optic thalamus, and replacing it, the dissector will comprehend the position and boundaries, on one side, of the great cleft of the brain.

is beneath fornix, and reaches base of brain.

This fissure lies beneath the fornix and splenium of the corpus callosum, and above the optic thalami and corpora quadrigemina (fig. 274, p. 757) ; and in the *dissected* brain it opens into the lateral ventricle along the edge of the fornix on each side, from the foramen of Monro to the extremity of the descending cornu. The slit opening into the lateral ventricle (*choroidal fissure*) is bounded by the edge of the fornix with the tænia hippocampi above and by the optic thalamus and crus cerebri below. A fold of

Pia mater enters it.

pia mater (velum interpositum) projects into the transverse fissure beneath the fornix (fig. 276, *g*), and forms lateral fringes—the choroid plexuses, which appear in the ventricles along the margins of the slit. In the natural state the fissure is separated from the cavity of the ventricle by the epithelium of the ependyma being continued over the choroid plexus, and therefore does not exist as a complete fissure except in the dissected specimen.

Parts in the middle of the brain.

The student is now to return to the examination of the parts in the centre of the brain, viz., the fold of pia mater and its vessels, with the third ventricle. Afterwards the corpus striatum and optic thalamus will be studied.

The VELUM INTERPOSITUM (fig. 276, *g*) is the fold of pia mater entering the great transverse fissure. Triangular in shape, it has the same extent as the body of the fornix, and reaches in front to the foramen of Monro. The upper surface is in contact with the fornix, to which it supplies vessels. The lower surface, looking to the third ventricle, covers the pineal body and a part of each optic thalamus: on it, close to the middle line, are the two choroid

Velum, or fold of pia mater

is over third ventricle,

FIG. 276.—SECOND VIEW OF THE DISSECTION OF THE BRAIN, THE FORNIX BEING CUT THROUGH IN FRONT AND RAISED BACKWARDS.

a. Fornix.
b. Hippocampus major.
c. Tænia hippocampi.
d. Caudate nucleus.
e. Optic thalamus.
f. Choroid plexus.
g. Velum interpositum.

plexuses of the third ventricle; and along each side is the choroid plexus of the lateral ventricle.

and carries choroid plexuses.

The CHOROID PLEXUS OF THE LATERAL VENTRICLE (fig. 276, *f*) is the red, somewhat rounded and fringed margin of the velum interpositum, which projects into the lateral ventricle, extending from the foramen of Monro to the extremity of the descending cornu. Its lower part is larger than the upper. The epithelium lining the ventricle is continued over the choroid plexus, but it loses its cilia in this situation. The right and left choroid plexuses are continuous

Choroid plexus of the lateral ventricle.

at the anterior extremity of the velum interpositum, where they are similarly excluded from the foramina of Monro by the epithelial lining.*

Vessels of the velum; arteries; veins;

Vessels of the velum. Small *arteries* have been already traced to the velum and the choroid plexus from the cerebral and cerebellar arteries (pp. 720, 721 and 724). There are two main ones on each side, *anterior and posterior choroid*, and they supply the surrounding cerebral substance. The *veins* of the choroid plexus receive branches from the ventricle, and end in the following:—

with veins of Galen.

Veins of Galen. Along the centre of the velum are placed two large veins with this name; they begin at the foramen of Monro, by the union of branches from the corpus striatum and the choroid plexus. Lying side by side in the membrane, they are usually united into one at the posterior part of the velum; and through this they pass out beneath the splenium of the corpus callosum and enter the straight sinus.

Dissection.

Dissection. When the velum interpositum has been raised and thrown backwards, the third ventricle will be opened (fig. 277). In reflecting the velum the student must be careful not to detach the pineal body behind, which is surrounded by the membrane and rests on the fore part of the anterior quadrigeminal bodies (fig. 277, *g*). On the under surface of the velum are seen the choroid plexuses of the third ventricle.

Choroid plexuses of third ventricle.

The CHOROID PLEXUSES OF THE THIRD VENTRICLE are two short and narrow fringed bodies below the velum, which resemble the like structures in the lateral ventricle.

Third ventricle is near base of brain.

The THIRD VENTRICLE is the narrow interval between the optic thalami (fig. 277). Its situation is in the median plane of the cerebrum, below the level of the lateral ventricles, with which it communicates; and it reaches to the base of the brain. Its boundaries and communications are the following:—

Roof.

Floor.

The roof is formed by the velum interpositum with the choroid plexuses, above which is the fornix. The floor (fig. 274) is very oblique from behind forwards, so that the depth of the cavity is about three-quarters of an inch in front and half as much behind: its hinder part is formed by the united tegmenta of the crura cerebri; and in front of these it corresponds with the parts at the base of the brain, which lie between the crura cerebri, viz., the posterior perforated space, the corpora albicantia, the tuber cinereum with the infundibulum, and the optic commissure. On the sides of the cavity are situate the optic thalami and the anterior pillars of the fornix (fig. 274). In front of the space are the anterior commissure and the lamina cinerea. Behind are the posterior commissure and the pineal body. Crossing the centre of the ventricle, from one optic thalamus to the other, is a band of grey matter—the *middle* or soft commissure; and care should be taken that this is not torn through in exposing the ventricle.

Parts on the sides, in front and behind.

* Particles of brain-sand, like that in the pineal body, are sometimes present in the choroid plexus.

This space communicates in front with each lateral ventricle through the foramen of Monro; and behind is a passage beneath

Openings into other ventricles.

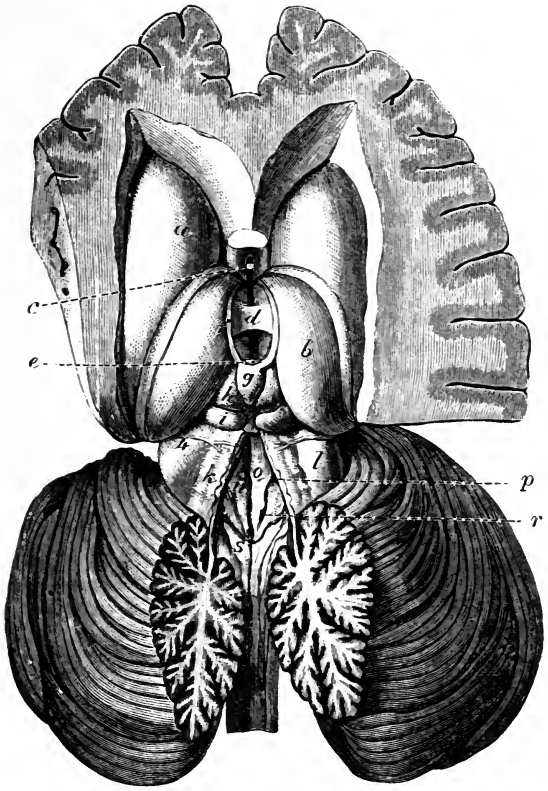


FIG. 277.—VIEW OF THE THIRD AND FOURTH VENTRICLES: THE FORMER BEING EXPOSED BY THE REMOVAL OF THE VELUM INTERPOSITUM; AND THE LATTER BY DIVIDING THE CEREBELLUM VERTICALLY IN THE MIDDLE LINE. THE THIRD VENTRICLE IS THE INTERVAL IN THE MIDDLE LINE BETWEEN THE OPTIC THALAMI.

a. Caudate nucleus.
b. Optic thalamus.
c. Anterior commissure, seen between the anterior pillars of the fornix.
d. Middle or soft commissure.
e. Posterior commissure.
f. Pineal stria.
g. Pineal body.
h and *i*. Corpora quadrigemina.
The fourth ventricle, *n*, is on the posterior surface of the medulla oblongata.
k. Valve of Vieussens.
l. Upper peduncle of the cerebellum.
o. Fasciculus teres.
p. Superior fovea.
r. Inferior fovea.
s. Clava.
4. Fourth nerve arising from the valve of Vieussens.

the corpora quadrigemina into the fourth ventricle, which is named the aqueduct of Sylvius. In the floor, in front, there is a

depression opposite the infundibulum, where the cavity at an early period of fœtal life was prolonged into the pituitary body.

Lining of cavity.

The ependyma lining the ventricle is continued into the neighbouring cavities through the different apertures of communication, and its epithelium is continued over the choroid plexuses in the roof.

Grey matter of the ventricle.

Grey matter of the ventricle. A stratum of grey matter forms the lower part of the wall of the ventricle. Portions of this layer appearing at the base of the brain constitute the posterior perforated space, the tuber cinereum and the lamina cinerea. It also extends into the corpus albicans, forming the nucleus of that body. At the fore part of each optic thalamus it covers the pillar of the fornix, and ascends to the septum lucidum. In the middle of the space it reaches from side to side, and forms the *middle* or soft commissure (*d*).

Corpus striatum, structure.

The CORPUS STRIATUM is the large grey body a part of which has been seen in the floor of the lateral ventricle. The grey matter composing it is incompletely divided into two masses—*caudate* and *lenticular nuclei*, by a layer of white fibres, named the *internal capsule;* and it has received its name from the striated appearance of this layer. The caudate nucleus, as already seen (fig. 275, *e*), is intraventricular in position, whilst the lenticular is extraventricular and requires further dissection to expose it.

Dissection.

Dissection. To show the composition of the corpus striatum, the upper part of that body and of the optic thalamus should be sliced off horizontally on the right side, until a view resembling that in fig. 278 is obtained. The superficial anatomy of the corpus striatum and optic thalamus may be studied on the left side at the same time by comparison.

Caudate nucleus shows in lateral ventricle:

The *caudate* or *intraventricular nucleus* (fig. 277, *a*) is a long pyriform mass of reddish-grey substance which projects into the lateral ventricle. Its larger extremity or *head* (fig. 278, *cn*) is turned forwards, and forms the floor and outer wall of the anterior cornu of the ventricle. The middle tapering portion is directed backwards and outwards, along the outer side of the optic thalamus, beneath the body of the ventricle, and ends in the *tail* (fig. 278, *cn'*), which bends downwards and is prolonged in the roof of the descending cornu of the cavity nearly to its anterior extremity. Numerous veins run over the surface of the caudate nucleus, and they may be seen to join a larger vessel (vein of the corpus striatum) which lies along the groove between the caudate nucleus and the optic thalamus.

veins on surface.

Lenticular nucleus is only seen in sections;

The *lenticular* or *extraventricular nucleus* is entirely surrounded by white matter, and is placed opposite the bottom of the fissure of Sylvius, corresponding to the Island of Reil on the exterior. It appears lens-shaped in horizontal section (fig. 278, *ln*), but triangular, with the base turned outwards, when cut transversely (fig. 279, p. 768). Internally, it is separated from the caudate nucleus and optic thalamus by the *internal capsule* (fig. 278, *ica* to *icp*);

surrounded by white capsule.

and externally and below, it is bounded by a thinner white layer named the *external capsule* (*ec*).

When the sections are carried to a little lower level than has so far been done (and this should now be done by removing thin slices Consists of three parts:

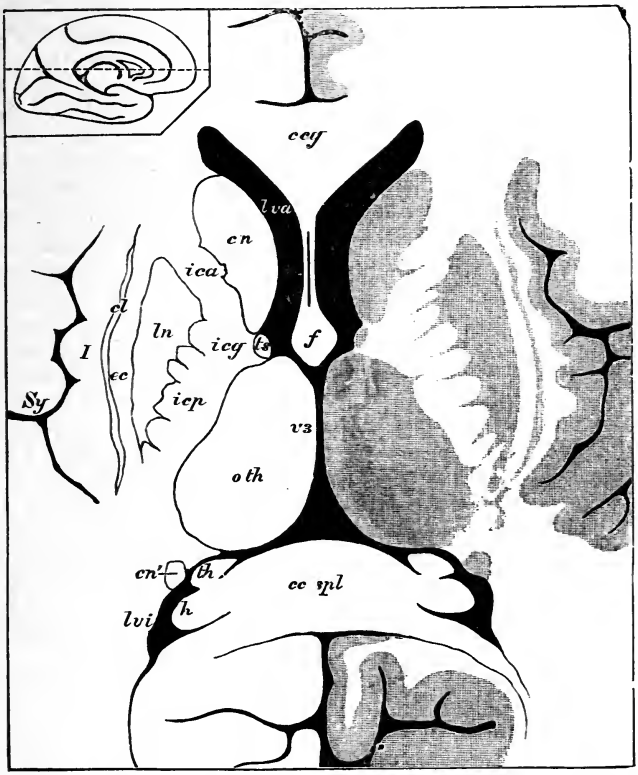


Fig. 278.—Middle Part of a Horizontal Section through the Cerebrum at the Level of the Dotted Line in the Small Figure of a Hemisphere in the Top Left-hand Corner of the Figure (after Dalton).

ccg. Genu, and *cc spl.* Splenium of corpus callosum.

f. Fornix; the septum lucidum, containing the fifth ventricle between its layers, unites the fornix with the corpus callosum.

lva. Anterior, and *lvi.* Descending cornu of the lateral ventricle.

cn. Caudate nucleus, head, and *cn'*, tail.

ts. Tænia semicircularis.

o th. Optic thalamus.

th. Tænia hippocampi.

h. Hippocampus major.

ica. Anterior limb, *icg.* Genu, and *icp.* Posterior limb of the internal capsule.

ln. Lenticular nucleus.

ec. External capsule.

cl. Claustrum.

I. Island of Reil.

Sy. Deep part of fissure of Sylvius.

of the lenticular nucleus only by horizontal sections) it will be found that the nucleus consists of three parts: an outer larger and more deeply coloured portion—the *putamen*—and two inner, paler putamen,

globus pallidus major and minor.

parts—the *globus pallidus major* and *minor*. The three parts are concentrically disposed from without inwards, and faint white lines indicate the separation between them.

Internal capsule,

The INTERNAL CAPSULE (figs. 278 and 279) is a thick layer of white fibres, which is seen in the horizontal section to form a bend, or *genu*, (fig. 278, *icg*), opposite the groove between the optic thalamus and the head of the caudate nucleus.

parts,

The part in front of the genu is named the *anterior limb* (*ica*), and the longer part behind is the *posterior limb* (*icp*) of the capsule.

source of fibres;

The internal capsule is formed in large part by the fibres of the crusta of the crus cerebri coursing upwards to the medullary centre of the hemisphere, but many fibres are added from the nuclei on each side.

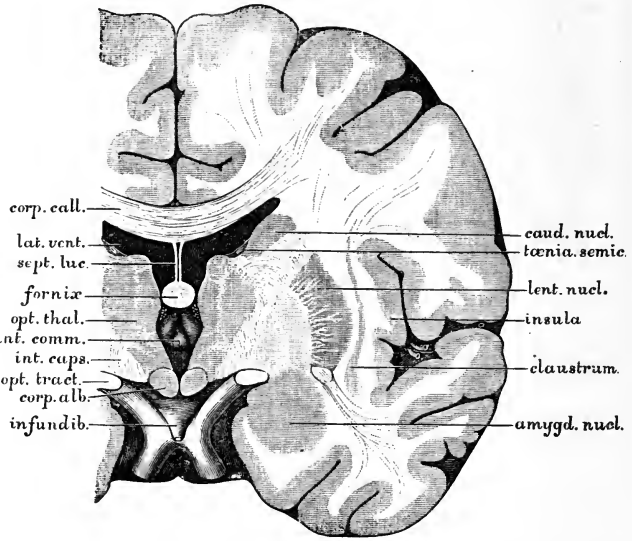


FIG. 279.—CORONAL SECTION OF THE CEREBRUM, PASSING THROUGH THE FORE PART OF THE THIRD VENTRICLE. THE ANTERIOR POSITION IS REPRESENTED (AFTER MERKEL).

pyramidal tract.

The pyramidal fibres, which have been traced from the medulla oblongata through the pons, and crusta, occupy the anterior two-thirds of the posterior limb. The posterior third of the posterior limb contains a few fibres that pass directly from the tegmentum, others which pass from the grey matter of the thalamus and, most posteriorly, fibres radiating *the optic radiation* to the angular and cuneate convolutions from the lower visual centres contained in the pulvinar of the optic thalamus, the external geniculate body and the anterior corpus quadrigeminum.

The anterior limb contains fibres which are connected with the grey matter of the head of the caudate nucleus and the cortex of the frontal lobe. The fibres of the capsule are collected into

separate bundles, between which the grey matter is continued from the caudate to the lenticular nucleus.

On the outer side of the external capsule, separating it from the medullary substance of the convolutions of the insula, is a third portion of grey matter, which appears, in sections, as a slightly wavy grey line: this is named the *claustrum* (fig. 278, *cl;* and fig. 279), and it represents an enlarged and well-defined fifth layer of the cerebral cortex. Claustrum.

The TÆNIA SEMICIRCULARIS (fig. 275, *f*) is a narrow whitish band of longitudinal fibres, which lies along the groove between the caudate nucleus and the optic thalamus. In front, the band becomes broader and joins the pillar of the fornix; behind, it is continued with the tail of the caudate nucleus into the roof of the descending cornu of the lateral ventricle, at the lower end of which it joins the amygdaloid nucleus. Tænia semicircularis.

Dissection. The *anterior commissure* is next to be exposed in its course through the cerebral hemisphere. For this purpose the remaining fore part of the caudate nucleus, the white fibres, and the lenticular nucleus, on the right side, must be successively scraped away with the handle of the scalpel, and the rounded band traced outwards from the spot where it is seen at the front of the third ventricle to the medullary centre of the temporo-sphenoidal lobe. Anterior commissure: dissection to show it;

The ANTERIOR COMMISSURE is a round bundle of white fibres about as large as a crow-quill, which is free only for about an eighth of an inch in the middle of its extent, where it lies in front of the pillars of the fornix (fig. 279). Laterally, it passes outwards beneath the corpus striatum, lying between the lenticular nucleus and the grey matter of the anterior perforated space, and curving backwards, spreads out in the white substance of the temporal lobe above the descending cornu of the lateral ventricle. its form, position, course, and ending.

The OPTIC THALAMUS (fig. 277, *b*) is an oval-shaped body which takes part in bounding the lateral and third ventricles. Its upper surface is marked by a shallow oblique groove, which corresponds to the edge of the fornix. The part of the surface inside the groove is in contact with the velum interpositum; but the narrower outer part is free in the floor of the lateral ventricle, and is covered by the ependyma of that cavity: at its anterior end it forms a slight prominence known as the *tubercle* of the optic thalamus. Externally this surface is bounded by the tænia semicircularis, which separates it from the caudate nucleus. The inner surface is for the most part free, forming the lateral wall of the third ventricle, but near the middle it is united to the one of the opposite side by the middle commissure (*d*). Along the line of junction of the upper and internal surfaces is a narrow white streak—the *pineal stria* (*f*), which springs behind from the stalk of the pineal body, and ends in front by joining the anterior pillar of the fornix. Optic thalamus: upper surface; inner surface;

The under surface is concealed, except at its hindmost part, by the crus cerebri, the tegmentum of which joins the thalamus; and lower and external surfaces;

on the outer side it is separated from the lenticular nucleus by the posterior limb of the internal capsule (fig. 278, *icp*).

anterior and posterior ends;

The anterior end of the optic thalamus bounds the foramen of Monro. The posterior end is much larger, and projects above the superior quadrigeminal body (fig. 277, *h*) and crus cerebri, being covered by the pia mater: behind and internally it forms a considerable prominence called the *pulvinar*; and below and outside, appearing at present as if it were a part of the optic thalamus, there is a smaller oval elevation named the *external geniculate body* (fig. 281, p. 772).

pulvinar;

external geniculate body;

structure.

In the section that has been made on the right side (fig. 278), the optic thalamus is seen to be composed of dark grey matter; but it appears white on the upper surface, the grey substance being here covered by a thin medullary layer. A faint white line, which bifurcates in front, divides the grey mass into three portions —a small anterior, a larger internal and an external nucleus.

Dissection of fornix.

Dissection. The origin of the fornix in the optic thalamus may now be followed out. As a preparatory step the anterior commissure, the front of the corpus callosum, and the commissure of the optic nerves should be cut along the middle line, so that the fore parts of the hemispheres can be separated from one another. On the left hemisphere the anterior pillar of the fornix is to be traced downwards through the grey matter of the third ventricle to the corpus albicans, and thence upwards into the optic thalamus. This can readily be done by following down the pillar of the fornix and scraping away the overlying soft grey substance.

Origin of fornix.

The ANTERIOR PILLAR OF THE FORNIX is joined below the foramen of Monro by the fibres of the tænia semicircularis and pineal stria, and then curves downwards and backwards in front of the optic thalamus, through the grey matter of the third ventricle, to the corpus albicans. Here it makes a turn like half of the figure 8, furnishing a white envelope to the grey matter of that body. Finally it ascends to the fore part of the optic thalamus, in the anterior nucleus of which its fibres end. The ascending band from the corpus albicans into the optic thalamus is commonly named the *bundle of Vicq d'Azir*.

The bodies lying behind the third ventricle, viz., the corpora quadrigemina, the pineal body, and the posterior commissure may be next examined.

Dissection.

Dissection. All the pia mater should be carefully removed from the surface of the quadrigeminal bodies, especially on the right side, on which they are to be seen. The posterior part of the hemisphere of the same side may be taken away if this has not been done already.

Midbrain.

The constricted portion of the brain between the optic thalami above and the pons and cerebellum below is known as the *isthmus cerebri* or *mesencephalon*, and occupies, when the brain is in the skull, the aperture of the tentorium cerebelli. The dorsal part of the mesencephalon is formed by a layer which is marked on the surface by four eminences—the *corpora quadrigemina*, and is

therefore named the *lamina quadrigemina*. The ventral part of the mid-brain is much larger, and constitutes the crura cerebri. The lamina quadrigemina is separated from the crura in the middle by a canal—the *aqueduct of Sylvius;* but on each side it is united with the tegmentum.

Lamina quadrigemina.

Aqueduct of Sylvius.

The CORPORA QUADRIGEMINA (fig. 277) are four prominent bodies, an upper and lower pair, which are separated by a crucial groove. The superior, or *anterior*, eminence (*h*) is the larger, and is rather oval in shape. The inferior, or *posterior*, (*i*) is smaller, but more prominent, and rounded; it is also whiter in colour than the upper one. From the outer side of each quadrigeminal body a white band, *brachium* (fig. 281) is continued outwards and forwards: the upper brachium passes into the optic tract; while the lower band sinks beneath a small but well defined oval prominence, which is placed between the crus cerebri and the optic thalamus, and is named the *internal geniculate body* (fig. 281).

Quadrigeminal bodies: anterior, posterior.

Brachia.

Internal geniculate body.

The quadrigeminal bodies are small masses of grey substance,

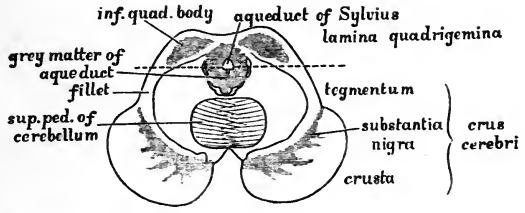


FIG. 280.—TRANSVERSE SECTION OF THE LOWER PART OF THE MIDBRAIN.

covered by a white layer. From the grey matter of the upper one fibres of the optic tract take origin.

Behind the quadrigeminal bodies are seen the superior peduncles of the cerebellum (fig. 277, *l*); with the valve of Vieussens, or *superior medullary velum* (*k*), between them. Issuing from beneath the transverse fibres of pons, and arching over the cerebellar peduncle, is an oblique, slightly raised band named the *fillet* (fig. 286 *f*, p. 782), which disappears under the lower quadrigeminal body and its brachium.

Below posterior the fillet is seen.

The FILLET is a white fibrous tract which appears in sections of the pons between the recticular formation and the deep transverse fibres (fig. 267 *fi*, and fig. 280). It is formed mainly by fibres continued upwards from the anterior and lateral columns of the same side of the spinal cord, by others from the nuclei of the posterior columns (cuneate and gracile) of the opposite side of the bulb, and, in its lateral portion, by fibres connected with the cochlear portion of the eighth nerve. At the upper edge of the pons the outer part of the fillet becomes superficial, and curving round the tegmentum (fig. 280), passes to the quadrigeminal bodies, particularly to the posterior, in which many of the fibres are lost, while others

Fillet: origin; ending of outer or superficial part, and

inner or deep part.

decussate in the lamina quadrigemina, above the aqueduct of Sylvius, with those of the opposite side. The inner fibres of the fillet maintain their deep position, and are continued upwards with the tegmentum to the cerebral hemisphere.

Optic tract arises from anterior quadrigeminal and external geniculate bodies, and thalamus.

The ORIGIN OF THE OPTIC TRACT can now be seen (fig. 281). At the outer side of the crus cerebri the optic tract forms a bend (genu), and then divides into two parts. The inner and smaller of these springs from beneath the internal geniculate body; while the outer is continued into the external geniculate body and the optic thalamus, receiving also the brachium of the anterior quadrigeminal body.

The proper visual fibres pass to the grey matter (1) of the pulvinar of the optic thalamus (2) of the external geniculate body, and (3) of the anterior corpus quadrigeminum. The fibres passing to the

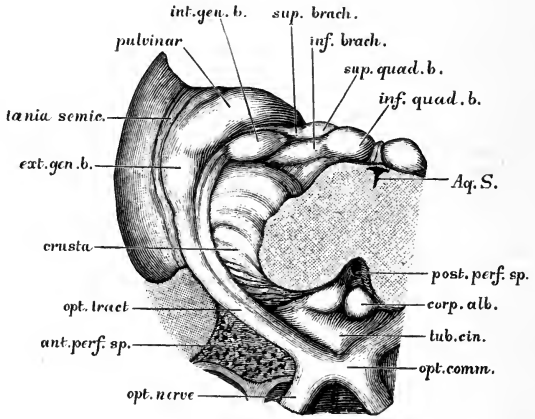


FIG. 281.—ORIGIN OF THE OPTIC TRACT. THE MESENCEPHALON IS DIVIDED CLOSE ABOVE THE PONS.

internal geniculate body, the most posterior fibres of the tract (see p. 728) are, apparently, not associated with vision.

Posterior commissure.

The POSTERIOR COMMISSURE (fig. 277, *e*) is the thin foremost part of the lamina quadrigemina, which is folded back so as to present a rounded margin in front towards the third ventricle, above the opening of the aqueduct of Sylvius (fig. 274, p. 757). On each side it joins the optic thalamus, and to its upper part the stalk of the pineal body is attached. It consists mainly of decussating fibres continuous with those of the fillet; but some are said to be commissural, uniting the tegmenta of the two sides.

Pineal gland;

The PINEAL BODY (conarium; fig. 274) is ovoidal in shape, like the cone of a pine, and about a quarter of an inch in length. It lies with its base turned forwards in the groove between the anterior quadrigeminal bodies. It is surrounded by pia mater; and its base is attached by a hollow white stalk, below to the posterior commissure, and above to the optic thalamus on each

side, along which it sends forwards the thin band already described as the pineal stria.

This body is of a red colour and very vascular. It is not composed of nervous substance, but consists of small follicles lined by epithelium, and containing minute granular masses of calcareous matter (brain-sand): similar concretions are often found on its surface, and adhering to its stalk. structure.

The AQUEDUCT OF SYLVIUS (iter a tertio ad quartum ventriculum; fig. 274) is a narrow passage, about five-eighths of an inch long, uniting the third and fourth ventricles and passing beneath Aqueduct of Sylvius.

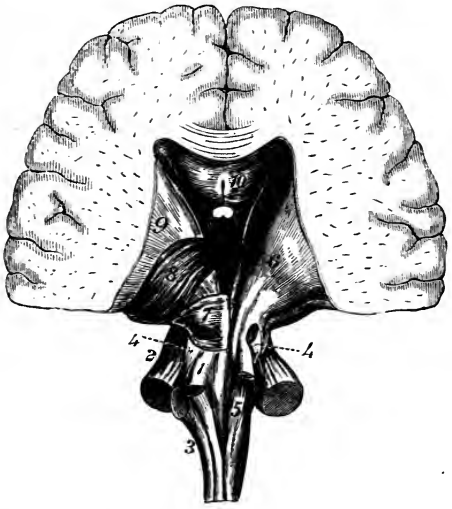


FIG. 282.—POSTERIOR VIEW OF THE CONNECTIONS BETWEEN THE CEREBRUM, MEDULLA OBLONGATA AND CEREBELLUM.

1. Superior : 2, Middle ; and 3, Inferior peduncle of the cerebellum.
4. Fillet.
5. Funiculus gracilis.
6. Tegmentum passing into the optic thalamus.
7. Lamina quadrigemina.
8. Optic thalamus.
9. Caudate nucleus.
10. Corpus callosum.

the quadrigeminal bodies and over the united tegmenta of the crura cerebri. It is lined by ependyma, external to which is a layer of grey matter continuous with that of the floor of the two cavities.

FIBRES OF THE CEREBRUM. In the cerebral hemispheres three systems of fibres are distinguished, viz., ascending, transverse, and longitudinal. The ascending are derived in large part from the spinal cord and the lower portions of the encephalon; the transverse and longitudinal connect together parts of the cerebrum. Three sets of fibres in cerebral hemisphere.

Ascending or *peduncular fibres* (fig. 282). The longitudinal fibres entering the midbrain from the pons are collected into two sets, Ascending fibres;

their origin. which are contained respectively in the crusta and the tegmentum. In this region they are reinforced by the superior peduncles of the cerebellum, and by fibres derived from the corpora quadrigemina, as well as by others springing from the grey nuclei of the crura.

Fibres of crusta, The fibres of the crusta enter the internal capsule; and while some (including the pyramidal tract) are continued without interruption through this into the medullary centre of the hemisphere, others pass into the lenticular and caudate nuclei, and fresh fibres are added from those bodies.

and of tegmentum. The longitudinal fibres of the tegmentum end for the most part in the grey matter of the optic thalamus, from the outer side of which also numerous fibres are given off to the capsule; but one tract of tegmental fibres, prolonged from the fillet, passes beneath the thalamus into the hinder part of the internal capsule, some of the outer fibres inclining to the side and traversing the inner part of the lenticular nucleus as they course upwards.

Dissection of them **Dissection.** A complete systematic view of the ascending fibres cannot now be obtained on the imperfect brain. At this stage the chief purpose is to show the passage of the radiating fibres from the crus through the large cerebral ganglia.

in the corpus striatum. To trace the ascending fibres through the corpus striatum, the caudate nucleus of this body should be scraped away (fig. 282); and the dissection should be made on the left side, on which the striate body and the optic thalamus remain uncut. In this proceeding the internal capsule comes into view, consisting of white fibres with intervening grey matter of the corpus striatum, giving the appearance of the teeth of a comb (pecten of Reil).

On taking away completely the hinder part of the caudate nucleus, others of the same set of fibres will be seen issuing from the outer side of the optic thalamus, and radiating to the posterior and inferior portions of the hemisphere.

Ascending fibres spread out in hemisphere, *Arrangement of the ascending fibres.* The fibres of the internal capsule diverge as they pass through the grey matter of the corpus striatum, and at the outer margin of that body they enter the medullary centre of the hemisphere, where they decussate with the transverse fibres of the corpus callosum, and radiate to all parts of the hemisphere. The ascending fibres thus form in the hemisphere

forming corona radiata. a part of a hollow cone, named the *corona radiata*, the apex of which is towards the crus cerebri, and the concavity turned downwards. The base of the cone is at the surface of the hemisphere, where the fibres pass into the grey cortex of the convolutions. From the foregoing description it will be evident that the fibres constituting the corona radiata are of two kinds, viz., those extending without interruption from the cortex to the crus cerebri, and those uniting the cortex with the corpus striatum and optic thalamus.

Transverse fibres. The *transverse* or *commissural fibres* connect the hemispheres of the cerebrum across the median plane. They give rise to the great commissure of the corpus callosum, and to the anterior commissure. These bodies have already been examined.

Longitudinal fibres, *Longitudinal* or *collateral fibres.* These are connecting fibres

which pass from before backwards, uniting together parts of the same hemisphere. The chief bands of this system which the student can recognise are the following: The fornix, the tænia semicircularis, the pineal stria, the longitudinal stria of the corpus callosum, and the cingulum. Other fibres pass in the medullary centre between adjoining and more distant convolutions, describing arches beneath the sulci: these are known as the *association-fibres.* known as association fibres.

Dissection. The dissector may now make a transverse section of the remains of the left hemisphere at the fore part of the optic thalamus, when the form and relations of the lenticular nucleus and the claustrum, together with the position of the anterior commissure, will be apparent (fig. 279). Make sections of lenticular nucleus,

Cuts should also be made into the geniculate bodies to show the grey nuclei within them. geniculate bodies,

By dividing transversely the left half of the midbrain through and mesencephalon.

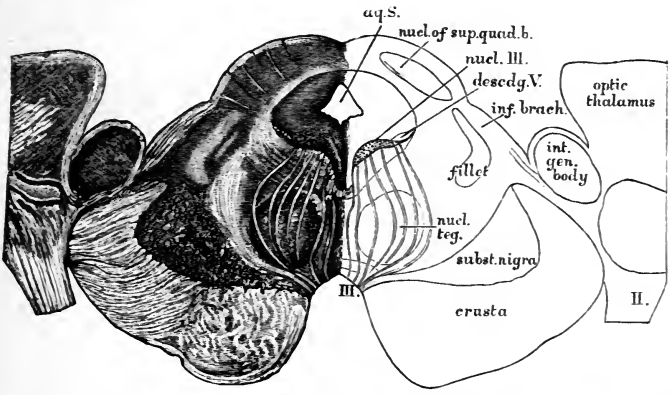


FIG. 283.—TRANSVERSE SECTION OF THE UPPER PART OF THE MIDBRAIN (AFTER OBERSTEINER).

the superior quadrigeminal body, there will be seen the grey matter of that eminence, the crusta and tegmentum separated by the substantia nigra, the red nucleus of the tegmentum, and the grey matter of the Sylvian aqueduct (fig. 283).

Finally, if the student has been working with two brains, he should make a longitudinal section through the remains of the pons, medulla and crus, passing a shade to the left of the middle line, and on examining the cut surface below the floor of the fourth ventricle and below the grey matter in the floor of the remains of the Sylvian aqueduct he will see a small, longitudinally running, band of white fibres coming up from the deeper parts of the medulla. This is the *posterior longitudinal bundle*, which chiefly consists of fibres running between the motor nuclei of the medulla, pons and midbrain. Longitudinal, through medulla and pons; posterior longitudinal bundle.

Section V.

THE CEREBELLUM.

Prepare cerebellum.

Dissection. The cerebellum is to be separated from the remains of the cerebrum by carrying the knife through the optic thalamus, so that the small brain, the corpora quadrigemina, the crura cerebri, the pons, and the medulla oblongata may remain united together.

Parts to be separated

Any remaining pia mater is to be carefully removed from the

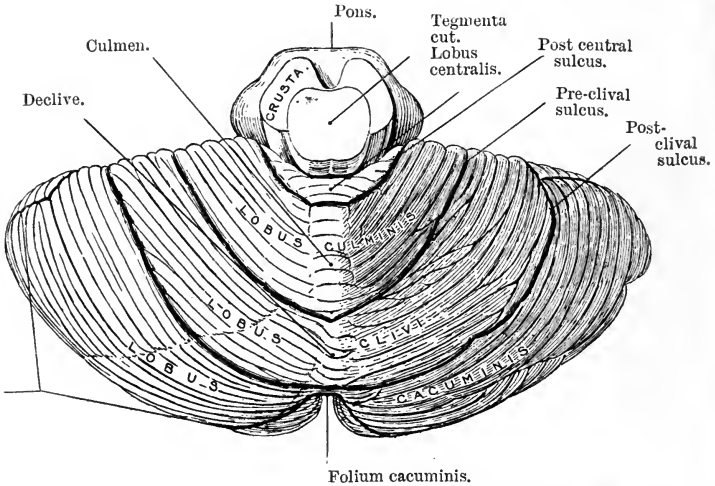


Fig. 284.—The Upper Surface of the Cerebellum.
The chief sulci are represented by thick lines.

from one another.

median groove on the under surface ; and the different bodies in that hollow are to be separated from one another. Lastly, the handle of the scalpel should be passed along a deep sulcus (the horizontal fissure) at the circumference of the cerebellum, between the upper and under surfaces.

Form and position of cerebellum.

The CEREBELLUM or small brain (figs. 284 and 285) is oval in shape, and flattened from above down. Its longest diameter, which is directed transversely, measures about four inches. This part of the encephalon is situate in the posterior fossa of the base of the skull, beneath the tentorium cerebelli.

Division into two.

Like the cerebrum, it is incompletely divided into two hemispheres ; the division being marked by a wide median groove along the under surface, and by a notch at the posterior border into which the falx cerebelli projects. The narrower part along the middle line uniting the two hemispheres is known as the *worm* (vermis).

Upper Surface. On the upper aspect the cerebellum is raised in the centre, and sloped towards the sides (fig. 284). There is not any median sulcus on this surface; and the hemispheres are united by a median part—the *superior vermiform process*. Separating the upper from the under surface, at the circumference, is the *horizontal fissure*, which extends from the middle, or pontine, peduncle in front to the median notch behind.

No groove on the upper surface; halves joined by upper worm. Horizontal fissure.

The **under surface** of the cerebellum is convex on each side, where it is received into the lower fossæ of the occipital bone; and the hemispheres are separated by a median hollow—*vallecula* (fig. 285), which is widest in front where it lodges the upper end of the medulla oblongata; the hinder end of the vallecula is con-

A hollow below, which is called valley,

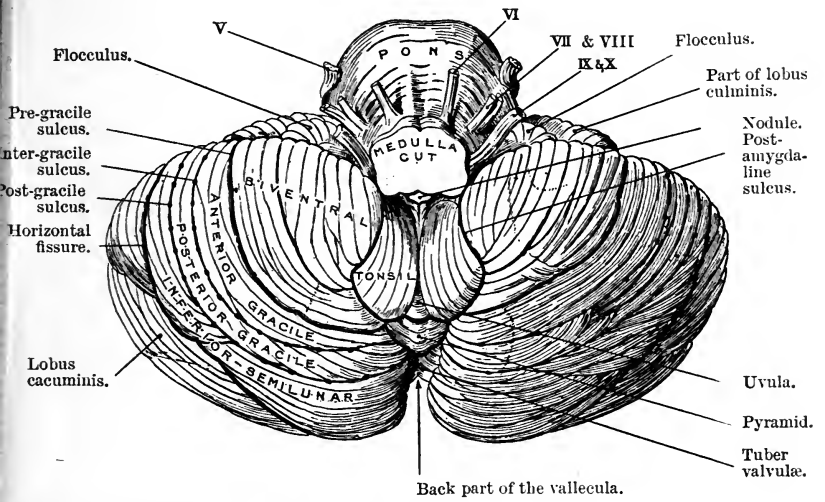


Fig. 285.—The Under Surface of the Cerebellum with the Medulla Removed.

The chief sulci are distinguished as in fig. 284.

tinued into the notch at the posterior border, and receives the falx cerebelli. At the bottom of the groove is an elongated mass named the *inferior vermiform process*, which corresponds to the central part uniting the hemispheres above. The two vermiform processes constitute the general commissure of the halves of the cerebellum.

and contains lower worm.

Laminæ and Sulci. The superficial part of the cerebellum is composed of grey substance, and is marked by concentric laminæ or folia, which have their free edges towards the surface, and run in a curved direction with the concavity turned forwards. The laminæ are separated by sulci, which are lined by pia mater, and are of variable depth. Only a small number of the laminæ appear on the surface, for many others are placed on the sides of the larger processes, and are concealed within the deeper sulci. The

Surface foliated. Between folia are sulci. Many folia are hidden.

laminæ, especially the smaller ones, are frequently interrupted by the junction of neighbouring sulci. On the upper aspect many of the laminæ pass continuously from one hemisphere to the other, with only a slight bending forwards in the superior vermiform process; but those of the under surface of the two hemispheres are connected by means of the special commissural bodies composing the inferior vermiform process. The deepest sulci of the hemisphere divide the laminæ into groups which are known as the lobes of the cerebellum.

Arrangement in worm.

Upper lobes are

LOBES OF THE UPPER SURFACE (fig. 284). On the upper surface the hemisphere is divided into four lobes by deep sulci which arch outwards and forwards from the superior vermiform process. Only three of these lobes, however, are wholly seen on the surface. Tracing them from behind forwards they are :—

from behind forwards,

1. The *lobus cacuminis* is semilunar in shape, and has its two lateral parts connected across the middle line by a single lamina (*folium cacuminis*), which is deeply placed at the bottom of the median notch.

lobus cacuminis,

2. The *lobus clivus*, crescentic in shape, and with its two lateral parts connected across the middle line by the slope (*declive*) of the superior worm.

lobus clivus,

3. The *lobus culminis*, similar in shape to and somewhat more massive than the preceding; its median portion forming the highest part (*culmen*) of the upper vermiform process; and

lobus culminis,

4. The *lobus centralis*, composed of about eight laminæ, which overlap the superior peduncle. Its lateral parts (*alæ*) are concealed by the most anterior portions of the lobus culminis.

lobus centralis,

On a mesial section of the cerebellum a small amount of grey matter (*lingula*) may be seen on the upper surface of the superior medullary velum (valve of Vieussens), in front of the central lobe (fig. 274, p. 757), and this may be considered as the most anterior representative of the grey matter of the upper surface of the cerebellum.

lingula.

Lower lobes are

The LOBES OF THE UNDER SURFACE of the hemisphere (fig. 285) are five in number. Beginning behind, and tracing them forwards, they are :—

inferior semilunar,

1. The *inferior semilunar lobe*, which is separated from the lobus cacuminis of the upper surface by the horizontal fissure.

gracile,

2. The *gracile lobe*, composed of four or five parallel laminæ, and often divisible into *anterior* and *posterior* parts.

biventral,

3. The *biventral lobe*, triangular in shape, and subdivided into two main parts. It reaches as far forwards as the flocculus, and is external to the following.

amygdaloid,

4. The *amygdaloid lobe*, or, the tonsil, which lies to the inner side of the biventral, and projects into the vallecula, touching the medulla oblongata, and concealing a part of the inferior vermiform process (the *uvula*), which is its representative in the middle line.

and the flocculus.

5. The *flocculus*, or sub-peduncular lobe, is placed in front of the biventral lobe, and curves upwards round the lower border of the crus cerebelli, being attached to the general mass of the small brain only by a narrow white stalk.

PARTS OF THE INFERIOR VERMIFORM PROCESS (fig. 285). On the inferior vermiform process there are seen, from behind forwards —first, a small eminence, comprising seven or eight narrow transverse laminæ which unite the posterior inferior and gracile lobes of the two sides and is named the *tuber valvulæ;* next, a larger, tongue-shaped projection, which serves as a commissure to the biventral lobes, and is called the *pyramid;* and then a narrow elongated part—the *uvula,* at the anterior extremity of which is the rounded prominence of the *nodule.* Lower worm includes tuber valvulæ, pyramid uvula, nodule,

The uvula is connected to the amygdaloid lobe on each side by a grey strip named the *furrowed band,* and the nodule to the flocculus by a thin white lamina—the *inferior medullary velum,* but to see these parts the following dissection must be made. furrowed band, and inferior medullary velum.

Dissection. The biventral and gracile lobes are to be sliced off on the left side, so that the amygdaloid lobe may be everted from the valley. By this proceeding the stalk of the flocculus is exposed, and is seen to be continued into the thin and soft white layer of the inferior medullary velum, which joins the nodule internally. The furrowed band is also exposed on the side of the uvula. Dissection.

The *inferior medullary velum* is a thin white layer which forms a commissure to the flocculi, and is connected to the upper surface of the nodule in the middle. Its exposed part on each side, between the flocculus and the nodule, is semilunar in shape, and the anterior edge is free; but behind, it is continued into the medullary centre of the cerebellum (fig. 274). Inferior medullary velum.

The *furrowed band* is a narrow ridge of grey matter, notched on the surface, which passes from the side of the uvula to the constricted base of the amygdaloid lobe. It lies along the attached posterior margin of the inferior medullary velum. Furrowed band.

STRUCTURE OF THE CEREBELLUM. The interior of the cerebellum consists of a large white mass—the *medullary centre,* from which offsets proceed to the laminæ and to other parts of the encephalon. The medullary centre is surrounded, except in front, where the processes to other parts of the brain (peduncles of the cerebellum) issue from it, by a superficial layer of grey substance—the *cortex of the cerebellum;* and other small masses of grey matter are embedded in it. Cerebellum consists of a white medullary centre and grey cortex.

Structure of the laminæ. The laminæ are seen, in the section that has been made of the separate cerebellum or of the under part of the left hemisphere, to consist of a grey external portion enveloping a white centre (fig. 277, p. 765). The grey matter is subdivided into two layers, the superficial of which is lighter and clear, while the deeper stratum is darker and of a rust colour. The white part is derived from the medullary centre, which sends off numerous processes to the lobes and the bodies composing the worm, and these, dividing like the branches of a tree, end in small offsets which enter the several laminæ. Laminæ are grey externally, and white within.

Dissection. For the purpose of seeing the medullary centre, with its contained corpus dentatum, remove all the laminæ from Dissection.

the upper surface on the left side. This dissection may be accomplished by placing the scalpel in the horizontal fissure at the circumference, and carrying it inwards as far as the upper vermiform process, so as to detach the anterior and posterior lobes of the upper aspect. If the corpus dentatum does not at first appear, thin slices may be made anteriorly till it is reached.

White centre

The *medullary centre* of the cerebellum forms a large oval mass in each hemisphere, but is flattened and narrow in the middle between the vermiform processes. The lateral part contains the grey corpus dentatum, and is continued in front into a large stalk-like process, which becomes divided into the three peduncles. From its surface, as already stated, offsets are furnished to the different lobes and laminæ. The white centre is composed mainly of the fibres of the peduncles radiating to the cortical grey matter; but there are in addition, as in the cerebrum, *commissural fibres* between the two hemispheres, which are most developed at the fore part of the superior vermiform process, and at the back close to the median notch, as well as a system of *association-fibres* uniting the laminæ beneath the sulci.

consists of radiating,

commissural,

and collateral fibres.

Dentate body: situation,

The *corpus dentatum* is situate in the inner part of the white mass of the hemisphere, and resembles the nucleus in the olivary body of the medulla oblongata. It measures about three-quarters of an inch from before back, and consists of a plicated capsule, which when cut across by *a sagittal section about a third of the way across the cerebellum from the middle line outwards*, appears as a thin, wavy, greyish-yellow line: it is open at the fore and inner part, and encloses a core of white substance. Through its aperture issue a band of fibres to join the superior peduncle.

and structure.

Other grey masses.

Between the two dentate bodies, embedded in the central white matter, are some smaller portions of grey substance, the chief of which is an oval mass on each side, nearly half an inch long, lying close to the middle line in the fore part of the superior vermiform process, and known as the *roof-nucleus* from its relation to the fourth ventricle (fig. 274).

Peduncles of the cerebellum (fig. 282, p. 773). These are three in number on each side, an upper (1) passing to the cerebrum, a middle (2) to the pons, and an inferior (3) to the medulla oblongata.

Superior peduncle:

The *superior peduncle* (processus ad cerebrum; fig. 277 *l*, p. 765) is directed forwards, and disappears beneath the corpora quadrigemina. It is rather flattened in shape, and forms part of the roof of the fourth ventricle. The processes of the two sides are united by the superior medullary velum, or the valve of Vieussens (*k*).

origin,

Its fibres are derived mainly from the interior of the dentate body, but a few are added from the white centre of the hemisphere and the worm.

and destination.

Beneath the corpora quadrigemina the superior peduncle enters the tegmentum of the crus cerebri, and crosses the middle line decussating with the one of the

opposite side. The fibres are then connected with the red nucleus of the tegmentum, and are continued with the longitudinal tegmental fibres to the optic thalamus.

Valve of Vieussens,

The *valve of Vieussens*, or *superior medullary velum*, is a thin translucent white layer which enters into the roof of the upper part of the fourth ventricle (fig. 277, *k*). It is narrow in front, but widens behind, where it is continued into the medullary centre of the worm. On each side it joins the superior peduncle. Near the lamina quadrigemina the fourth nerve is attached to the valve : and its upper surface is covered by four or five small transverse grey ridges, constituting the *lingula*.

covered by lingula.

Middle peduncle.

The *middle peduncle* (processus ad pontem), commonly named the crus cerebelli, is the largest of the three processes. Its fibres begin in the lateral part of the hemisphere, and are directed forward to the pons, of which they form the transverse fibres.

Inferior peduncle to medulla.

The *inferior peduncle* (processus ad medullam) passes downwards to the medulla oblongata, where it is known as *the restiform body*. Its fibres begin chiefly in the laminæ of the upper surface of the hemisphere. It will be better seen when the fourth ventricle has been opened.

Dissection.

Dissection. One other section (fig. 277) must be made to expose the fourth ventricle. The cerebellum still resting on its under surface, let the knife be carried vertically through the centre of the vermiform processes ; and then the structure of the worm, as well as the boundaries of the fourth ventricle, may be observed on separating the lateral portions of the cerebellum.

Vermiform process is like other parts.

Structure of the Worm (fig. 274). The upper and lower vermiform processes of the cerebellum are united in one central piece which connects together the hemispheres. The structure of this connecting piece is the same as that of the rest of the cerebellum, viz., a central white portion and investing laminæ. Here the branching appearance of a tree (*arbor vitæ*) is best seen, in consequence of the laminæ being more divided, and the white central stalk being thinner and more ramified.

Fourth ventricle:

The FOURTH VENTRICLE (fossa rhomboidalis) is a space between the cerebellum and the posterior surface of the medulla oblongata and pons (fig. 274). It has the form of a lozenge, with the points placed upwards and downwards. The upper angle reaches as high as the upper border of the pons ; and the lower, nearly to the level of the lower end of the olivary body. Its greatest breadth is opposite the lower edge of the pons ; and a transverse line in this situation would divide the hollow into two triangular portions—upper and lower. The lower half has been named *calamus scriptorius* from its resemblance to a writing pen.

form and extent ; breadth : calamus scriptorius.

Boundaries on side :

The *lateral boundaries* are more marked above than below. For about half way down the cavity is limited on each side by the superior peduncle of the cerebellum, which, projecting over it, forms part of the roof ; and along the lower half lies the eminence of the restiform body, with the clava of the funiculus gracilis (fig. 286, *cl*) at the inferior extremity. At the lower border of the

lateral recess.

middle peduncle of the cerebellum a lateral process of the cavity extends outwards over the surface of the restiform body.

Roof. The *roof* of the space is formed above by the valve of Vieussens with the superior peduncles of the cerebellum, and by the inferior medullary velum and nodule of the inferior vermiform process; below by the reflection of the pia mater from that process to the medulla oblongata. Between the valve of Vieussens and the inferior medullary velum the ventricle forms an angular recess, the apex of which is directed towards the medullary centre of the worm.

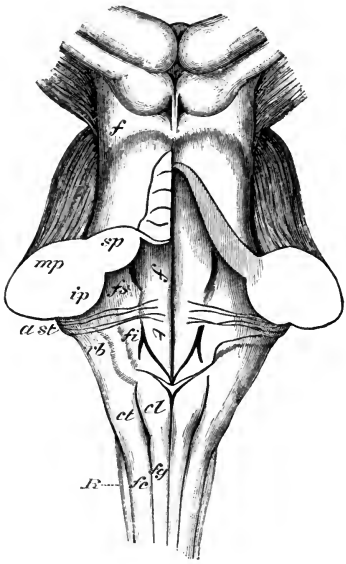


Fig. 286.—Back of Medulla Oblongata and Pons, showing the floor of the fourth Ventricle.

f. Fillet.
sp. Superior.
mp. Middle, and
ip. Inferior peduncle of the cerebellum; attached to the superior peduncle on the left side is the half of the superior medullary velum, covered by the lingula.
ft. Fasciculus teres.
fs. Superior fovea.
fi. Inferior fovea.
a st. Auditory striæ.
rb. Restiform body.
cl. Clava. Crossing the restiform body of the right side, below the auditory striæ, is the lingula.

Floor; objects in it are a median groove, fasciculus teres, auditory striæ,

The *floor of the ventricle* (fig. 286) is constituted by the posterior surface of the medulla oblongata and pons, and is greyish in colour. Along the centre is a median groove, which ends below, near the point of the calamus, in a minute hole—the aperture of the canal of the cord. On each side of the groove is a spindle-shaped elevation, the *fasciculus* s. *eminentia teres* (*ft*). This eminence reaches the whole length of the floor, and is pointed and well defined below, but less distinct above. Its widest part is opposite the centre of the ventricle.

Crossing the floor on each side, at the lower border of the pons, are some white lines — the *auditory striæ* (*a st*), which vary much in their arrangement: they issue from the median groove, and pass outwards to the auditory nerve.

The fasciculus teres is limited externally by two small depressions —the *superior* and *inferior foveæ*, separated by the auditory striæ. The *superior* (*fs*) is the broader, and is connected to the lower one by a faint groove. The *inferior foveæ* (*fi*) is well marked, and has the form of the letter V inverted. The triangular portion between the two branches is of a darker colour than the surface on each side,

superior and inferior fovea,

and is named the *ala cinerea* (fig. 287, *ac*): it corresponds to the nucleus of the vagus nerve. On the outer side of the fovea the surface is elevated over the principal nucleus of the auditory nerve, forming the *auditory tubercle* (*at*), which is crossed by the auditory striæ.

ala cinerea,

auditory tubercle,

In the upper half of the floor of the ventricle there may be seen, on the inner side of the superior fovea, a rounded elevation of the fasciculus teres, produced by the nucleus of the sixth nerve. And lastly, above the superior fovea is a narrow, slightly depressed area of a bluish colour (locus cæruleus), caused by a deposit of very dark grey substance (substantia ferruginea) beneath the thin surface-layer.

nucleus of sixth nerve,

and locus cæruleus.

The fourth ventricle communicates above with the third ventricle through the aqueduct of Sylvius, and with the subarachnoid space below through an aperture (*foramen of Majendie*) in the pia mater between the cerebellum and medulla oblongata. Below, also, it opens into the central canal of the cord. It is lined by ependyma, the epithelium of which is continued over the pia mater in the roof, and prolonged upwards and downwards into the canals leading from the ventricle.

Openings into other cavities.

Foramen of Majendie.

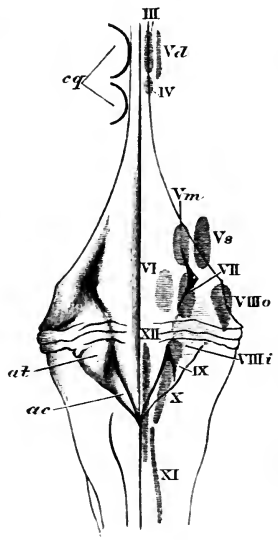


FIG. 287.—DIAGRAM SHOWING THE POSITION OF THE NERVE-NUCLEI NEAR THE FLOOR OF THE FOURTH VENTRICLE. THE ROMAN NUMBERS INDICATE THE NUCLEI OF THE CORRESPONDING NERVES.

Vd. Nucleus of the descending root.

Vm. Motor nucleus, and

Vs. Sensory nucleus of the fifth nerve.

VIII*o*. Outer, and

VIII*i*. Inner auditory nucleus.

XI. Upper part of the spinal accessory nucleus. On the left side:

cq. Position of the corpora quadrigemina.

at. Auditory tubercle.

ac. Ala cinerea.

Projecting into the lower half of the ventricle is a vascular fold on each side, the *choroid plexus*, similar to the body of the same name in the lateral and third ventricles. It is attached to the inner surface of the pia mater which closes the ventricle between the medulla and the cerebellum, and extends from the point of the calamus scriptorius to the extremity of the lateral recess of the cavity. It receives branches from the inferior cerebellar artery.

Choroid plexus of cavity.

The floor of the fourth ventricle is covered by a layer of grey matter, which is continuous below with the grey commissure of the cord, and above with the grey substance of the aqueduct.

Grey layer of floor.

NUCLEI OF CRANIAL NERVES (fig. 287). In the dorsal portion of the medulla oblongata and pons are situate the collections of nerve-cells from which many of the cranial nerves take their origin.

Nerve nuclei in and near

floor of fourth ventricle.

Some of these appear in the floor of the fourth ventricle, while others are placed a little below the surface.

In lower half of floor, four nuclei, viz., of twelfth,

Beneath the calamus scriptorius, and in the portion of the floor of the cavity formed by the medulla oblongata, are the nuclei of the twelfth, tenth, ninth and eighth nerves. The *hypoglossal nucleus* (XII) extends through nearly the whole length of the medulla oblongata; its lower part is hidden, lying in front of the central canal below the level of the fourth ventricle, but its upper half approaches the surface in the lower portion of the fasciculus teres.

tenth, ninth,

The *main nucleus of the vagus* (X) corresponds to the ala cinerea, and is continued above into the chief *glosso-pharyngeal nucleus* (IX) which lies beneath the inferior fovea. The position of the *inner* or *principal nucleus* of the *vestibular division* of the auditory nerve (VIII*i*) is indicated by the area acustica; and the dorsal nucleus of the *cochlear division* (VIII*o*) by an enlargement just above the acoustic striæ.

and eighth nerves.

Beneath upper half are five nuclei, viz., of sixth, seventh, two of fifth,

In the hinder part of the pons, and beneath the upper half of the floor of the ventricle, are nuclei of the fifth (two), sixth, seventh and eighth nerves, but only that of the sixth is indicated by a superficial prominence. The *nucleus of the sixth* (VI) lies beneath the elevation of the fasciculus teres above the auditory striæ. The *facial nucleus* (VII) is placed external to and deeper than the last; and the *motor nucleus of the fifth nerve* (V*m*) is above that of the facial. The *sensory nucleus of the fifth* (V*s*) lies external to the foregoing, and just beyond the lateral margin of the ventricle.

In midbrain three nuclei, viz., of third, fourth, and fifth nerves.

Above the fourth ventricle, in the grey matter surrounding the aqueduct of Sylvius, are the *nuclei of the fourth* (IV) and *third* (III) *nerves* in the floor, and the *nucleus of the descending root of the fifth* (V*d*) on the side of the canal.

Further details of these nuclei are given on pages 728 to 730.

TABLE OF THE CHIEF ARTERIES OF THE HEAD AND NECK.

- Arch of the aorta furnishes to the neck
  - 1. The Innominate.
    - 1. Right common carotid.
      - 1. External carotid.
        - 1. Superior thyroid
          - Infra-hyoid branch
          - superior laryngeal
          - thyroid.
        - 2. lingual
          - Supra-hyoid branch
          - dorsal lingual
          - sublingual
          - ranine.
        - 3. facial
          - Ascending palatine branch
          - tonsillar
          - glandular
          - submental
          - inferior labial
          - coronary (inferior, superior)
          - lateral nasal
          - angular
        - 4. occipital
          - Sterno-mastoid branch
          - mastoid
          - princeps cervicis
          - meningeal?
          - cranial
        - 5. posterior auricular
          - Stylo-mastoid branch
          - auricular
          - stylo-mastoid.
        - 6. ascending pharyngeal
          - Pharyngeal branches
          - prevertebral
          - meningeal.
        - 7. superficial temporal.
          - Auricular
          - parotid
          - transverse facial
          - middle temporal
          - anterior superficial temporal
          - posterior superficial temporal.
        - 8. internal maxillary
          - Inferior dental
          - tympanic and auricular
          - middle and small meningeal
          - posterior dental
          - muscular
          - infraorbital
          - spheno-palatine
          - descending palatine
          - Vidian
          - pterygo-palatine.
      - 2. Internal carotid.
        - 1. Arteriæ receptaculi
        - 2. ophthalmic.
          - Central of the retina
          - ciliary
          - lachrymal
          - supraorbital
          - muscular
          - ethmoidal (anterior and posterior)
          - palpebral
          - frontal
          - nasal.
        - 3. posterior communicating
        - 4. anterior cerebral
        - 5. middle cerebral
        - 6. anterior choroid.
    - 2. Right subclavian.
      - 1. Vertebral (with basilar).
        - Posterior meningeal
        - posterior spinal
        - anterior spinal
        - inferior cerebellar (anterior and posterior)
        - transverse basilar
        - superior cerebellar
        - posterior cerebral.
      - 2. internal mammary
      - 3. thyroid axis.
        - Inferior thyroid
          - Ascending cervical
          - tracheal, œsophageal
          - inferior laryngeal
          - thyroid.
        - suprascapular
      - 4. superior intercostal.
        - transverse cervical.
          - Superficial cervical
          - posterior scapular.
        - Deep cervical.
  - 2. Left common carotid

TABLE OF THE CHIEF VEINS OF THE HEAD AND NECK.

- Innominate is joined by
  - Internal jugular
    - 1. Lateral sinus
      - Superior longitudinal sinus (on right side)
      - straight sinus (on left side)
        - Inferior longitudinal sinus
        - veins of Galen
      - occipital sinus
      - superior petrosal sinus
    - 2. inferior petrosal sinus.
      - Cavernous sinus and ophthalmic veins.
    - 3. pharyngeal
      - Meningeal branches
      - prevertebral
      - pharyngeal.
    - 4. lingual
      - Superficial dorsal
      - lingual venæ comites
      - ranine.
    - 5. facial
      - Angular
        - Supraorbital
        - frontal
        - palpebral
        - nasal
      - inferior palpebral
      - lateral nasal
      - anterior internal maxillary
        - Nasal veins
        - vidian
        - superior palatine
        - infraorbital
        - posterior dental
      - labial
      - submental
      - inferior palatine
      - tonsillar
      - glandular
      - anterior part of temporo-maxillary (The trunk formed as shown below).
    - 6. superior thyroid
      - Thyroid
      - laryngeal.
    - 7. middle thyroid.
  - subclavian
    - External jugular
      - 1. Posterior part of temporo-maxillary vein, formed by temporal
        - Anterior
        - posterior
        - middle temporal
        - parotid
        - anterior auricular
        - transverse facial
      - and internal maxillary
        - Middle meningeal
        - inferior dental
        - deep temporal
        - pterygoid
        - masseteric.
      - 2. posterior auricular
      - 3. transverse cervical
        - Superficial cervical
        - posterior scapular.
      - 4. suprascapular
      - 5. anterior jugular.
    - vertebral
      - Spinal
      - deep cervical
      - anterior vertebral
      - highest intercostal.
      - Occipital.
    - internal mammary
    - inferior thyroid.

TABLE OF THE CRANIAL NERVES.

1. First nerve . . Filaments to the nose.
2. Second nerve . . To retina of the eyeball.
3. Third nerve . . To ciliary muscle and sphincter iridis and muscles of the orbit, except external rectus and superior oblique.
4. Fourth nerve . . To superior oblique muscle.
5. Fifth or trifacial nerve .
   - Ophthalmic .
     - Recurrent lachrymal . . . → Lachrymal; palpebral.
     - frontal . . . . → Supraorbital; supratrochlear.
     - nasal . . . . → To lenticular ganglion; long ciliary nerves; infratrochlear; internal nasal; external nasal; anterior nasal.
   - ophthalmic or lenticular ganglion . .
     - Connecting branches . → To nasal nerve; to third nerve; to sympathetic.
     - short ciliary nerves.
   - superior maxillary . .
     - Orbital branch . → Malar; temporal.
     - spheno-palatine
     - posterior dental
     - middle dental
     - anterior dental
     - infraorbital.
   - Meckel's ganglion . .
     - Internal branches . → Upper lateral nasal; naso-palatine.
     - ascending . . . To the orbit.
     - descending . . . → Large palatine; small palatine; external palatine.
     - posterior . . . → Vidian . . . . → To facial nerve; to sympathetic; pharyngeal.
   - inferior maxillary . .
     - anterior part . → Deep temporal; masseteric; buccal; pterygoid.
     - posterior part . → Auriculo-temporal . → Articular; to meatus; parotid; auricular; temporal.
     - posterior part . → lingual . . . . → To submaxillary ganglion; to hypoglossal; to the tongue.
     - nerve to internal pterygoid. → inferior dental . → Mylo-hyoid; dental; mental; incisor.
   - otic ganglion .
     - Connecting branches . → To trunk of inferior maxillary; to Jacobson's nerve; to auriculo-temporal; to sympathetic.
     - branches for muscles . → To tensor palati; to tensor tympani.
   - submaxillary ganglion . .
     - Connecting branches → To the lingual, chorda tympani, and sympathetic.
     - branches to glands and mucous membrane of mouth.

TABLE OF THE CRANIAL NERVES—*continued.*

- 6. Sixth nerve . . . To external rectus.
- 7. Seventh nerve, or facial
  - Connecting branches
    - To join auditory
    - to Meckel's ganglion
    - to tympanic and sympathetic nerves
    - chorda tympani
    - to auriculo-temporal
  - branches for distribution
    - Posterior auricular
    - digastric branch
    - stylo-hyoid branch
    - temporo-facial
      - Temporal
      - malar
      - infraorbital.
    - cervico-facial
      - Buccal
      - supramaxillary
      - inframaxillary.
- 8. Eighth nerve, or auditory
  - To the facial
  - upper part
    - To the utricle
    - to the superior and external semi-circular canals.
  - lower part
    - To the cochlea
    - to the saccule
    - to the posterior semicircular canal.
- 9. Ninth nerve or glosso-pharyngeal
  - Connecting branches
    - To vagus
    - to sympathetic
    - Jacobson's nerve
      - To sympathetic
      - to otic ganglion, ultimately to the parotid gland
      - supplies tympanum.
  - branches for distribution
    - To the pharynx
    - tonsillitic branches
    - to stylo-pharyngeus
    - lingual.
- 10. Tenth nerve, or pneumo-gastric
  - Connecting branches
    - To glosso-pharyngeal
    - to sympathetic
    - auricular nerve
    - to hypo-glossal and cervical nerves.
  - branches for distribution
    - Pharyngeal
    - superior laryngeal
      - External laryngeal
      - ascending, descending } to the mucous membrane
      - to join inferior laryngeal.
    - cardiac nerves
    - inferior laryngeal
      - Cardiac
      - œsophageal, tracheal
      - to inferior constrictor and muscles of larynx
      - to join superior laryngeal.
    - gastric and intestinal
- 11. Eleventh nerve, or spinal accessory
  - Connecting branches
    - To pneumo-gastric
    - to the cervical plexus.
  - branches for distribution
    - To sterno-mastoid and trapezius
- 12. Twelfth nerve or hypo-glossal
  - Connecting branches
    - To pneumo-gastric nerve
    - to sympathetic
    - to loop on atlas
    - to lingual of fifth.
  - branches for distribution
    - Descending branch
    - thyro-hyoid nerve
    - to genio-hyoid
    - to lingual muscles.

TABLE OF THE SPINAL AND SYMPATHETIC NERVES OF THE HEAD AND NECK.

Spinal Nerves.

- The cervical spinal nerves divide into
  - Anterior branches
    - The first four form the CERVICAL PLEXUS, which gives
      - Superficial ascending: Small occipital nerve; great auricular; superficial cervical.
      - superficial descending: Acromial; clavicular; sternal.
      - deep internal: To pneumo-gastric; to hypoglossal; to sympathetic; to ansa hypoglossi; to prevertebral muscles; to diaphragm.
      - deep external: To sterno-mastoid; to levator anguli scapulæ; to scalenus medius; to trapezius; to join spinal accessory.
    - The last four and part of first dorsal form the BRACHIAL PLEXUS, which gives
      - Branches above the clavicle: The rhomboid nerve; to phrenic nerve; suprascapular nerve; to subclavius; posterior thoracic; to scaleni muscles.
      - branches below: Are dissected with the upper limb.
  - posterior branches: Are distributed to the muscles of the back, and give off cutaneous nerves.

Sympathetic Nerve.

- The sympathetic nerve in the neck.
  - 1. Superior cervical ganglion has
    - Ascending branches, which unite in plexuses
      - Carotid plexus, which gives branches: To tympanic plexus; to Vidian nerve; to sixth and fifth cranial nerves.
      - Cavernous plexus, which gives branches: To third cranial nerve; to fourth cranial nerve; to ophthalmic nerve; to lenticular ganglion; to carotid artery and branches.
    - external branches: To join pneumo-gastric and hypoglossal nerves; to spinal nerves.
    - internal branches: Pharyngeal branches; superficial cardiac nerve.
    - branches to vessels: Nervi molles.
  - 2. Middle cervical ganglion
    - External branches: To spinal nerves.
    - internal: Middle cardiac nerve; to supply thyroid body and join external laryngeal; loop over subclavian artery
  - 3. Inferior ganglion
    - External: To spinal nerves; vertebral plexus.
    - internal: Inferior cardiac nerve,

CHAPTER XI.

DISSECTION OF THE EYE.

Situation of the eyeball; surrounding sheath.

THE eyeball is the organ of vision, and is lodged in the orbit. Supported in that hollow on a mass of fat, it is surrounded by muscles which impart movement to it; and a thin membrane (*tunica vaginalis oculi* or *capsule of Tenon*) isolates the ball, so as to allow free movement.

Parts in front of it.

Two lids protect the eye from external injury, and regulate the amount of light admitted into the interior; and the anterior or exposed surface is covered by a mucous membrane (*conjunctiva*).

The dissection to be made on the eye of the ox.

Directions. In the absence of specimens of the human eye, the structure may be learnt on the eye of the pig or ox. Let the student procure half a dozen eyes of the ox for the purpose of dissection. One or two shallow basins will be needed; and some wax or tallow in the bottom of one, or in a deep plate, will be useful.

Detach the muscles.

Dissection. To see the general form of the ball of the eye, and the outer surface of the external coat, the attachments of the different muscles are to be taken away; and the loose mucous membrane is to be removed from the front.

Form of the ball.

The *ball of the eye* (fig. 288) consists of two parts, which differ in appearance, viz., an opaque white posterior portion (sclerotic), forming about five-sixths of the whole, and a smaller transparent piece (cornea) in front; these two parts are segments of different sized spheres, the anterior belonging to the smaller sphere. To the back of the eye the optic nerve is attached, rather to the inner side of the axis of the ball; and around it ciliary vessels and nerves enter.

Position of optic nerve.

Diameter.

The antero-posterior diameter of the ball amounts to nearly an inch ($\frac{1}{2}\frac{9}{0}$ths), but the transverse measures an inch.

Composition; number of coats, and central parts.

The organ of vision is composed of central transparent parts, with enclosing membranes or coats. The coats, placed one within another, are named sclerotic, choroid, and retina. The transparent media in the interior are likewise three, viz., the lens, the aqueous humour, and the vitreous body.

Dissection.

Dissection. To obtain a general idea of the structures to be dissected, the student may destroy one eyeball by cutting through it circularly; he will then be able to recognise the arrangement of the parts mentioned above, with their strength and appearance, and will be better prepared to follow the directions that are afterwards given.

FIBROUS COAT OF THE EYEBALL. The outer casing of the eye consists of an opaque hinder part called sclerotic, and of an anterior transparent portion, the cornea. Fibrous coat.

The SCLEROTIC is the firm, whitish, opaque portion of the outer coat of the eyeball, which supports the more delicate structures within. Sclerotic part.

Dissection. To examine the inner and outer surfaces of this layer, it will be necessary to cut circularly with scissors through the Dissection to see the interior.

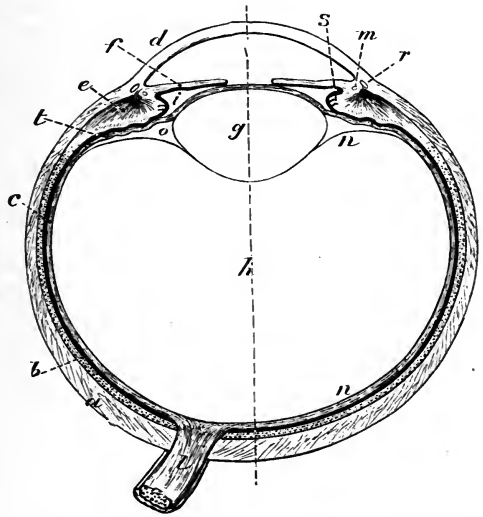


FIG. 288.—DIAGRAM OF A HORIZONTAL SECTION OF THE EYEBALL.

a. Sclerotic coat.
b. Choroid.
c. Retina, continuous with the optic nerve behind, with a dark layer outside it.
d. Cornea.
e. Ciliary muscle.
f. Iris.
g. Lens.
h. Vitreous body.
i. Posterior chamber of the aqueous.
l. Optic nerve.
m. Circular fibres of the ciliary muscle.
n. Hyaloid membrane.
o. Canal of Petit.
r. Canal of Schlemm.
s. Ciliary process.
t. Suspensory ligament of lens.
The dotted line through the centre is the longitudinal axis of the ball.

cornea close to the sclerotic, and to remove the cornea from the front of the eyeball; on piercing the cornea the aqueous fluid escapes from the containing chamber. The other structures may be then abstracted from the interior of the sclerotic covering, and may be set aside in water with the cornea for subsequent use.

The sclerotic tunic of the eye (fig. 288, *a*) extends from the entrance of the optic nerve to the margin of the cornea, forming above five-sixths of the ball. Extent of sclerotic;

At its back, and a little to the inner side of the centre (one-tenth apertures behind,

of an inch), the optic nerve (*l*) is transmitted through an aperture in it; this opening decreases in size from without inwards, and is cribriform when the nerve is drawn out,—the lattice-like condition being due to the bundles of fibrous tissue between the funiculi of the nerve. Small apertures for the passage of vessels and nerves are situate around the optic nerve; and there are others for vessels at the front and the centre of the ball. Anteriorly the sclerotic is continuous with the transparent cornea.

and before; ending in front;

outer and inner surfaces;

On the outer surface this coat is smooth, except where the muscles are attached: on the inner aspect it is of a dark colour, with flocculi of fine areolar tissue (membrana fusca) uniting it to the next coat, and with the ends of ruptured vessels and nerves.

thickness;

The sclerotic covering is thickest at the back of the eyeball, but it becomes thinner and whiter about a quarter of an inch from the cornea, where it is visible as the "white of the eye." Towards the junction with the cornea it is again somewhat thickened.

circular sinus;

In its substance, near the union with the cornea, is a small flattened venous space, the *canal of Schlemm* (sinus circularis iridis; fig. 288, *r*).

composed of fibrous tissue; vessels and nerves.

Structure. The sclerotic consists of bundles of fibrous tissue, which interlace with one another, but run for the most part longitudinally and transversely. Its vessels are very scanty. Minute filaments of the ciliary nerves have been described, entering the deep surface of the membrane.

Cornea: extent and size; form;

Cornea (fig. 288, *d*). This firm transparent membrane forms about one-sixth of the eye-ball, and measures about half an inch across. Its shape is circular, though when viewed from the front it appears larger in the transverse direction, in consequence of the opaque sclerotic structure encroaching farther on it above and below than on the sides.

thickness;

It is convex in front and concave behind; and its thickness is nearly uniform (from $\frac{1}{20}$th to $\frac{1}{30}$th of an inch), except near the circumference, where it is somewhat thicker at the junction with the sclerotic.

surfaces;

The anterior surface of the cornea is slightly less extensive than the posterior, owing to its being overlapped by the sclerotic.

curve;

Supported by the aqueous humour, it is tense and nearly spherical during life; but its radius of curvature varies in different individuals, and in the same person at different ages, being shorter in the young.

condition after death.

After death it becomes flaccid from the transudation of the aqueous humour; or if the eye is immersed in water, it is rendered opaque by infiltration of the tissues by that fluid.

It consists of laminar fibrous tissue, with conjunctiva in front, and an elastic membrane behind;

Structure. The substance of the cornea is composed of a special kind of connective tissue, arranged in irregular layers. Over the front the conjunctiva (which is here reduced to its epithelium) is continued; and covering the back of the cornea proper is a very thin elastic stratum known as the *membrane of Descemet.* The latter may be peeled off, after a cut has been made through it, in shreds which curl up with the attached surface innermost. At the circumference of the cornea the membrane of Descemet breaks up

into processes (*pillars of the iris* or *ligamentum pectinatum iridis*) which are partly reflected on to the front of the iris, and partly join the sclerotic and choroid coats.

In the healthy condition the blood-vessels do not permeate the cornea, but cease in capillary loops at the circumference. Numerous fine branches of the ciliary nerves ramify in its substance. no vessels; many nerves.

Vascular Coat of the Eyeball (fig. 289). The next covering is situate within the sclerotic, and is formed in large part of blood-vessels; the muscles of the interior of the ball also belong to this coat. Vascular and muscular coat.

It is constructed of three parts,—a posterior (*choroid*) corresponding with the sclerotic, an anterior (*iris*) opposite the cornea, and an intermediate ring (*ciliary muscle*) on a level with the union of the sclerotic and cornea. Components.

Dissection. Supposing the cornea of an eye cut through circularly as before directed, it will be necessary to take away the sclerotic to lay bare the choroid coat. With the point of the scalpel or with a shut scissors, detach the fore part of the sclerotic from the front of the choroid by breaking through a soft whitish structure uniting them. Then, the eye being put into water, the outer coat is to be removed by cutting it away piecemeal with the scissors; in taking it off, the slender vessels and nerves beneath are to be preserved. The white ring round the eye in front, which comes into view during the dissection, is the *ciliary muscle.* Dissection to see the choroid portion.

For the purpose of obtaining a front view of the ciliary processes, which are connected with the anterior termination of the choroid coat, let the cornea be removed as before on another eyeball. Detach next the fore part of the sclerotic from the choroid; and after three or four cuts have been made in it towards the optic nerve, the resulting flaps may be pinned out, so as to support the eye in an upright position (fig. 289). On removing with care the iris, taking it away from the centre towards the circumference, the ciliary processes beneath will be displayed. A posterior view of the processes may be prepared on another ball by cutting through it circularly with scissors, about one-third of an inch behind the cornea, so that the anterior can be removed from the posterior half; on taking away the portion of the vitreous mass adherent to the anterior part of the ball, and washing off the pigment from the back of the iris, the small processes will be made manifest. By means of the last dissection the interior of the choroid coat may be seen. To show the ciliary processes by an anterior and a posterior view.

If a vertical sagittal section is made of another eyeball (fig. 290), it will show the ciliary processes in their natural position, and will demonstrate the relative situation of all the parts. This section, which is made with difficulty, should be attempted in water with a large sharp knife, and on a surface of wax or wood, after the cornea and sclerotic have been cut with scissors. When the eye has been divided, the halves should remain in water. To make a vertical section.

The Choroid Coat (fig. 288, *b*) is a thin membrane of a dark colour, and extends from the optic nerve to the fore part of the Choroid: extent;

anterior termination; eyeball. When viewed on the eye in which the ciliary muscle is entire, it appears to terminate there; but it may be seen in the other dissections to pass inwards behind the muscle, and to end in a series of projections (ciliary processes) at the back of the iris.

relations of outer surface, This covering is rather thicker and stronger behind than in front. Its outer surface is for the most part only slightly attached to the sclerotic by delicate bands of areolar tissue, and has a flocculent appearance when detached; but in front the ciliary muscle unites the two coats more firmly: on this surface may be seen small veins arranged in arches, and the ciliary arteries and nerves

of inner; (fig. 289). The inner surface is smooth, and is lined by the thin

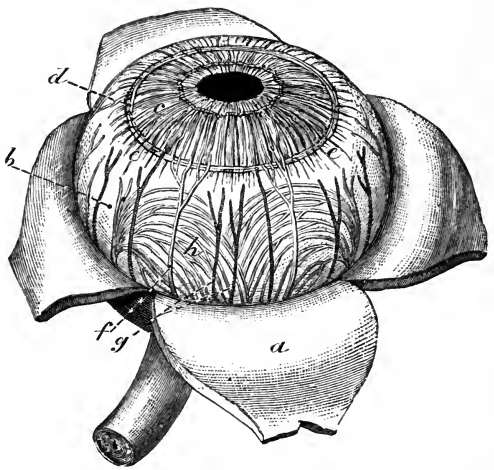


FIG. 289.—VIEW OF THE FRONT OF THE CHOROID COAT AND IRIS—EXTERNAL SURFACE (ZINN).

a. Sclerotic, cut and reflected.
b. Choroid.
c. Iris.
d. Circular.
e. Radiating fibres of ciliary muscle.
f. Ciliary nerves, and *g*, ciliary arteries, between the two outer coats.
h. Veins of the choroid coat (vasa vorticosa).

opening behind. dark pigmentary layer of the retina (fig. 288). Posteriorly it is pierced by a round aperture for the passage of the optic nerve; and anteriorly it joins the iris.

Ciliary processes; The *ciliary processes* (fig. 290, *b*) are solid projections on the inner surface of the choroid coat, disposed radially, and forming a

arrangement; circle beneath the ciliary muscle and the outer margin of the iris.

two kinds; About seventy in number, they comprise larger and smaller eminences, the former being the more numerous, and having a length of about one-tenth of an inch. They increase in depth from without inwards; and at their inner ends they are united by transverse ridges.

By their free extremities the processes bound peripherally the space (posterior chamber; fig. 291, *i*, p. 796) behind the iris; in front, they correspond to the ciliary muscle, and at their inner ends to the back of the iris; while behind, they are closely applied to the membrane on the front of the vitreous body (suspensory ligament of the lens; fig. 291, *t*), and fit into hollows between eminences on the anterior surface of that structure. relations to parts around.

Structure. The choroid coat and its ciliary processes are composed of blood vessels supported by pigmented areolar tissue. Most externally is a delicate stratum of connective tissue known as the *lamina suprachoroidea*, similar to the membrana fusca of the sclerotic, to which it is connected; next to this is a layer containing the larger ramifications of the arteries and veins; and in the deepest part the vessels form a very fine and close capillary network (*tunica Ruyschiana*). In the ciliary processes the meshes of the capillary network are larger, and the interstitial pigment disappears towards the free ends of the larger processes. Structure of choroid, supra-choroid layer, and vascular networks; ciliary processes.

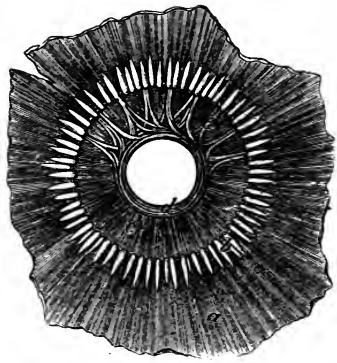


FIG. 290.—POSTERIOR VIEW OF THE FORE PART OF THE CHOROID COAT WITH ITS CILIARY PROCESSES, AND THE BACK OF THE IRIS.

a. Anterior piece of the choroid coat.
b. Ciliary processes.
c. Iris.
d. Sphincter of the pupil.
e. Bundles of fibres of the dilator of the pupil, represented diagrammatically.

CILIARY MUSCLE (fig. 289, *d*, *e*). In the eye from which the sclerotic coat has been removed, the white ring of the ciliary muscle may be seen covering the front of the choroid coat. Ciliary muscle: position;

The muscle forms a circular band, of a greyish white colour, and about one-tenth of an inch wide, on the surface of the choroid coat close to the outer margin of the iris. It consists of unstriated fibres, which are in two sets, radiating and circular:—

The *radiating fibres* (fig. 291, *e*) arise in front from the sclerotic coat close to the junction with the cornea (beneath *r*), and are directed backwards, spreading out, to be inserted into the choroid coat opposite to, and a little behind, the ciliary processes. Some of the deeper fibres become transverse, and pass gradually into the following set. consists of radiating

The *circular fibres* are beneath the radiating, and form a narrow bundle (fig. 291, *m*) surrounding the edge of the iris, opposite the inner part of the ciliary processes. and circular fibres;

Action. The ciliary muscle draws forwards the fore part of the choroid coat and the ciliary processes, and relaxes the suspensory ligament of the lens, thereby allowing the lens to become more use.

convex, as required for vision at near distances. The ciliary muscle is therefore the *muscle of accommodation*.

Iris is vascular and muscular;

The IRIS (fig. 289, *c*) is a vascular and muscular structure, about half an inch in diameter, the vessels of which are continuous with those of the choroid coat. Its position and relations may be observed in the different dissections that have been prepared.

situation;

Placed within the ring of the ciliary muscle, it is suspended in front of the lens (fig. 288, *f*), and is pierced by an aperture for the

form;

transmission of the light. It is circular in form, is variously coloured in different persons, and is immersed in the aqueous humour.

attachment;

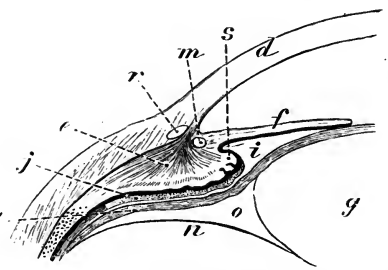
By its circumference, it is connected with the choroid coat, and by

anterior surface;

the ligamentum pectinatum with the cornea. The anterior surface is free in the aqueous humour, and is marked by lines converging towards the pupil. The

posterior surface.

posterior surface is covered with a thick layer of pigment (fig. 291), to which the term *uvea* has been applied.



The pupil.

The aperture in it (fig. 289) is the *pupil* of the eye; this is slightly internal to the centre, and is nearly circular in form; but its size is constantly varying (from $\frac{1}{20}$th to $\frac{1}{3}$rd of an inch) by the contraction of the muscular fibres, according to the degree of light acting on the retina.

FIG. 291.—ENLARGED REPRESENTATION OF THE PARTS OF THE EYEBALL ON ONE SIDE OPPOSITE THE LENS: THE LETTERS REFER TO THE SAME PARTS AS IN FIG. 288.

d. Cornea.
e. Ciliary muscle, radiating fibres.
f. Iris.
g. Lens.
i. Posterior chamber.
j. Ciliary part of the retina.
m. Circular bundle of the ciliary muscle.
n. Front of vitreous body.
o. Canal of Petit.
r. Canal of Schlemm.
s. Inner end of ciliary process.
t. Suspensory ligament of the lens.

Membrane of the pupil in the fœtus:

Membrane of the pupil. In the fœtus the aperture of the pupil is closed by a vascular transparent membrane, which is attached to the edge of the iris, and divides into two distinct chambers the space in which the iris is

situation;

suspended. The vessels in it are continuous behind with those of the iris

time of disappearance.

and the case of the lens. About the eighth month the vessels become impervious, and at the time of birth only fragments of the structure remain.

Component structures.

Structure. The stroma of the iris is composed of connective tissue, the fibres of which are directed for the most part radially towards the pupil. In it are involuntary muscular fibres, both circular and radiating, together with pigment-cells; and vessels and nerves ramify through the tissue.

Sphincter

Muscular fibres. The *sphincter of the pupil* (fig. 290, *d*) is a narrow band about $\frac{1}{30}$th of an inch wide, which is close to the

and dilator of pupil.

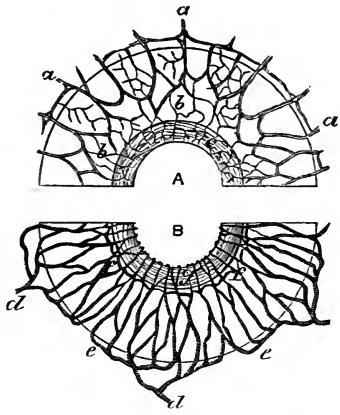
pupil, on the posterior aspect of the iris. The *dilator of the pupil* (*e*)

consists of bundles of fibres which begin at the outer border of the iris, and end internally in the sphincter.

Action. Enlargement of the pupil is effected by shortening of the radiating fibres; and diminution, by contraction of the circular ring. The movements of the iris are involuntary, and regulate the admission of light into the ball. How they act.

The *pigment* of the iris is partly interspersed in the substance of the membrane, and partly collected into a thick layer on the posterior aspect, the above-mentioned uvea, which is continuous with the pigmentary stratum of the retina. The colour of the iris depends upon the nature and quantity of the interspersed pigment. Situation of pigment.

The *arteries* of the iris (fig. 292, B) have a looped arrangement; they are derived chiefly from the long and the anterior ciliary branches (*d*), but some come from the vessels of the ciliary processes. On arriving at the ciliary muscle, the long and anterior ciliary arteries form a circle (*e*) round the margin of the iris; from this ring other anastomotic branches are directed towards the pupil, near which they join in a second arterial circle (*f*). From the last circle capillaries run to the edge of the pupil, and end in veins.



Arteries form two circles.

FIG. 292.—DISTRIBUTION OF THE NERVES AND VESSELS OF THE IRIS.

A. Half of the iris showing the nerves.
a. Nerves entering the membrane, and uniting in a plexus.
b. Within it. (Kolliker.)
B. Half of the iris with a plan of the vessels. Veins.
d. Ciliary arteries.
e. Arch of vessels at the outer edge of the iris.
f. Inner circle of vessels in the iris. Nerves of the iris.
g. Sphincter of the pupil.

The *veins* resemble the arteries in their arrangements in the iris, and terminate in the veins of the choroid coat.

The *nerves* of the iris are the terminal branches of the ciliary nerves; they divide into branches which accompany the blood vessels, and communicate with one another so as to form a plexus which gets gradually finer towards the pupil (fig. 292, A).

CILIARY VESSELS AND NERVES (fig. 289). The ciliary arteries are offsets of the ophthalmic, and supply the choroid, the ciliary processes, and the iris. They are classed into posterior and anterior, and two of the first set are named long ciliary; but they will not be seen without a special injection of the vessels of the eye. Arteries of the middle coat:

The *posterior ciliary arteries* (*g*) pierce the sclerotic coat around and close to the optic nerve, and running forwards on the posterior ciliary,

choroid, divide into branches which enter its substance at different points.

two of them named long ciliary,

Two of this set (*long ciliary*) are directed forwards between the sclerotic and choroid, one on each side of the eyeball, and form a circle round the iris in the ciliary muscle, as before explained. In the ball the outer one lies rather above, and the inner, rather below the middle.

anterior ciliary.

The *anterior ciliary arteries*, five or six in number, are smaller than the posterior, and arise at the front of the orbit from muscular branches; they pierce the sclerotic coat about a line behind the cornea, supply the ciliary processes; and join the circle of the long ciliary vessels. In inflammation of the iris these vessels are enlarged, and offsets of them form a ring round the cornea.

Veins are posterior ciliary,

The *posterior ciliary veins* have a different arrangement from the arteries. The branches form arches (*vasa vorticosa;* fig. 289, *h*) in the superficial part of the choroid coat, external to the arteries, and converge to four or five trunks, which perforate the sclerotic coat about midway between the cornea and the optic nerve to end in the ophthalmic veins.

and anterior ciliary.

The *anterior ciliary veins* begin in a plexus within the ciliary muscle, receiving tributaries from the iris and the ciliary processes, and accompany the arteries through the sclerotic to end in the ophthalmic trunks: they communicate with the venous space of the canal of Schlemm.

Ciliary nerves

The *ciliary nerves* (fig. 289, *f*) are derived from the lenticular ganglion, and the nasal nerve. Entering the back of the eyeball with the arteries, they are continued with the vessels between the sclerotic and choroid as far as the ciliary muscle: at this spot the nerves send offsets to the cornea, and piercing the fibres of the ciliary muscle, enter the iris. Offsets from the nerves supply the ciliary muscle and the choroid, and fine twigs enter the sclerotic.

end in iris and ciliary muscle.

Space containing aqueous humour

Chamber of the Aqueous Humour (fig. 288, p. 791). The space between the cornea in front and the lens behind, in which the iris is suspended, contains a clear fluid named the aqueous humour. In the fœtus before the seventh month this interval is separated into two by the iris and the pupillary membrane; but in the adult it is only partly divided, for the two communicate through the pupil. The boundaries of the two chambers may be seen in the eye on which a vertical section has been made.

is partly divided into two by the iris:

anterior part;

The *anterior chamber* is the larger of the two; it is limited in front by the cornea, and behind by the iris.

posterior, its boundaries.

The *posterior chamber* (*i*) is a narrow interval behind the iris at the circumference, which is bounded in front by the iris; behind by the lens capsule, and by a piece of the membrane (suspensory ligament of the lens) on the front of the vitreous humour; and at the circumference by the ciliary processes.

Retina

The Retina (fig. 288, *c*). This layer is the innermost and most delicate of the coats of the eyeball, and is situate between the choroid coat and the transparent mass (vitreous) in the interior. It consists of two parts, viz., a thin membrane internally, continuous

is in two parts.

with the optic nerve, and a pigmentary layer outside, which adheres to the choroid coat.

Dissection. The retina can be satisfactorily examined only on an eye which is obtained within forty-eight hours after death. To bring it into view on the eyeball in which the middle coat was dissected, the choroid must be torn away carefully with two pairs of forceps, while the eye is immersed in fluid. In this dissection the pigmentary layer separates from the nervous portion of the retina, and is removed with the choroid coat.

Dissection to see the retina.

The *pigmentary portion of the retina* is a very thin, dark layer, which lines closely the inner surface of the choroid coat, and is continued over the ciliary processes into the uvea on the posterior surface of the iris (fig. 291).

Pigmentary membrane.

The *nervous portion of the retina* is a soft membrane of a pinkish grey tint and semitransparent when fresh; but it soon loses this translucency, and is moreover rendered opaque by the action of water and other substances. In the living state, however, the retina is characterised by the existence of a purplish red colour, which is discharged under the influence of sunlight. This part of the retina extends over about the posterior two-thirds of the eyeball, reaching from the entrance of the optic nerve to the outer extremities of the ciliary processes, where it ends in an irregular wavy border—the *ora serrata*. Its thickness diminishes from behind forwards.

Nervous retina:

appearance and colour vary;

extent:

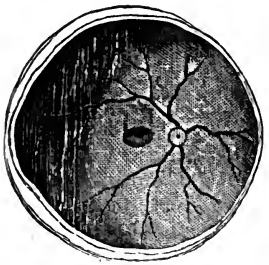


Fig. 293.—Objects on the Inner Surface of the Retina (Sœmmerring).

In the centre of the ball is the yellow spot, here represented by shading: and in its middle the fovea centralis. To the inner side is the optic disc with the branching of the artery.

thickness;

outer surface;

inner surface presents

The outer surface of the dissected retina is slightly flocculent, owing to the tearing away of the pigmentary layer. The inner surface is smooth: it is covered with folds in a preparation of the eye cut in two, but these are accidental, in consequence of the membrane having lost its proper support. At the spot where the optic nerve expands (*porus opticus*, *optic disc*; fig. 293) the surface is slightly elevated (*papilla optica*); but in the centre of this is a slight excavation where the central vessels appear.

optic disc,

central vessels,

In the interior of the human eye, in the axis of the ball, is a slightly elliptical yellow area (fig. 293), one-twelfth of an inch in diameter, which is named the *yellow spot* (*macula lutea*). Almost in the centre of this spot is a minute hollow, the *fovea centralis*, which appears black in consequence of the thinness of the wall allowing the dark pigment outside to be seen.

yellow spot, and central fovea.

From the ora serrata a very thin layer is continued on as far as the tips of the ciliary processes; it is called the *ciliary part of the*

Ciliary part of retina.

retina, but does not consist of nervous substance. It is not visible to the naked eye.

For a description of the structure of the retina, the student is referred to a work dealing with microscopic anatomy.

Artery of retina

has four chief branches;

Vessels of the retina. The *central artery of the retina*, accompanied by its veins, enters the eyeball through the optic nerve. In the central depression of the optic papilla the artery divides into four primary branches,—two inner or nasal (upper and lower), and two outer or temporal (also upper and lower). The outer branches are the larger, and follow an arched course above and below the yellow spot: all ramify in the innermost part of the nervous coat. No vessels enter the pigmentary layer. The veins have a similar arrangement.

another in fœtus.

In the fœtus a branch of the artery passes through the centre of the vitreous mass to supply the lens-capsule.

Vitreous body.

Vitreous Body. This is a soft transparent mass which fills the greater part of the space within the coats of the eyeball (fig. 288, *h*).

To obtain a view of it,

Dissection. The vitreous body may be seen on the eye on which the retina was dissected, by taking away the retina, the iris, and the ciliary muscle and processes.

and of its front.

To obtain a view of its anterior part, with the lens in situation, an eyeball should be fixed upright, and the sclerotic and choroid coats cut through about a quarter of an inch behind the cornea; then on removing carefully the cornea, the ciliary muscle and processes, and the iris, the vitreous body will be apparent.

Form and position of vitreous:

it consists

of jelly,

The *vitreous body* (fig. 288, *h*) is globular in form, and fills about four-fifths of the ball, supporting the retina. In front it is slightly hollowed, and receives the lens (*g*), with its capsule to which it is closely united. It is composed of a thin watery jelly, contained in a transparent membrane named hyaloid. The jelly consists in great part of fluid, which drains away when the vitreous body is exposed on a flat surface, or placed on a filter, and only a very small amount of solid matter remains. In the central part of the vitreous body, however, there is a canal filled with fluid (*hyaloid canal*), which extends from the optic papilla of the retina to the back of the lens-capsule, and served in the fœtus for the transmission of the capsular branch of the central artery of the retina: but this canal is not visible without special preparation.

with a central canal;

and of the hyaloid membrane:

The *hyaloid membrane* (*n*) is the thin, glassy, structureless layer enclosing the vitreous body, except at the fore part where the lens is placed. At the bottom of the ball, around the optic papilla, the membrane is closely connected with the retina; and it sends a prolongation forwards to line the canal of the vitreous. In front, the membrane becomes thicker as it approaches the ciliary processes, and is continued into the suspensory ligament of the lens.

both are without vessels.

The vitreous mass and the hyaloid membrane are extravascular, and receive their nutritive material from the vessels of the ciliary processes and retina.

Suspensory ligament:

Suspensory ligament of the lens (Zonule of Zinn). This is a transparent membranous structure (fig. 291, *t*), placed around

the lens-capsule, which joins externally the hyaloid membrane opposite the anterior termination (ora serrata) of the retina. After the ciliary processes of the choroid coat are detached from it, dark lines of pigment cover the surface; and when these are washed away, plaits (*ciliary processes*) come into view, which are less prominent and longer than the processes of the choroid coat, but do not quite reach the lens-capsule internally. The two sets of prominences are dovetailed together,—the projections of one being received into hollows between the other; and in the fresh state the two structures are closely adherent. The membrane contains numerous stiff radiating fibres, which internally become collected into bundles, and are attached to the margin, and the adjacent part of the anterior surface of the lens-capsule. The tenseness is influenced by the state of the ciliary muscle, for during its contraction the membrane is rendered lax by the drawing forwards of the ciliary processes.

extent; is marked by folds; inner attachment; condition how altered.

Canal of Petit. Around the margin of the lens-capsule is a narrow space (fig. 288, *o*) about one-tenth of an inch across, which is situate between the suspensory ligament and the front of the vitreous humour. When the canal has been opened, and filled with air by means of a blow-pipe, it is sacculated at regular intervals, like the large intestine, by the inflation of the plaits of the anterior boundary. The margin of the capsule of the lens bounds the space internally.

Canal of Petit: situation; anterior part sacculated.

LENS AND ITS CAPSULE. The lens is situate behind the pupil of the eye (fig. 288, *g*), and brings to a focus on the retina the rays of light entering through that aperture.

Lens of the eyeball.

The CAPSULE is a firm and very elastic transparent case, which closely surrounds the lens proper. The anterior surface is free, and projects towards the pupil, around which it touches the iris; but externally the two are separated by a small interval—the posterior chamber (*i*); close to the margin of the lens it is joined by the suspensory ligament (*t*). The posterior surface is received into a hollow on the front of the vitreous body, to which it is inseparably united. The circumference of the case gives attachment to the posterior fibres of the suspensory ligament, and behind this bounds the canal of Petit (*o*).

Capsule of the lens: relations of anterior surface, posterior surface, and circumference;

The capsule is a structureless glassy membrane, much thicker over the front of the lens, as far out as the attachment of the suspensory ligament, than over the back, where it is very thin in the centre. In the adult human eye the capsule of the lens is not provided with blood-vessels; but in the fœtus a branch of the central artery of the retina supplies it.

is a homogeneous membrane; vessels only in fœtus.

Dissection. The lens will be obtained by cutting across the thin membranous capsule in which it is enclosed.

Open capsule of lens.

The LENS is a solid and transparent doubly convex body; but the curves are unequal on the two surfaces, the posterior being greater than the anterior. Its margin is somewhat rounded; and the measurement from side to side is one-third of an inch, but from before back about one-fifth of an inch. The density increases

Surfaces are curved unequally; dimensions density;

from the circumference to the centre; for while the superficial layers may be rubbed off with the finger, the deeper portion is firm, and is named the *nucleus*.

lines on the surfaces;

On each surface are three lines diverging from the centre, and reaching towards the margin; they are the edges of planes or "septa," where the ends of the lens-fibres meet, and are so situate that those on one side are intermediate in position to those on the other. In the human eye they are not distinctly seen, because they bifurcate repeatedly as they extend outwards.

structure is laminar

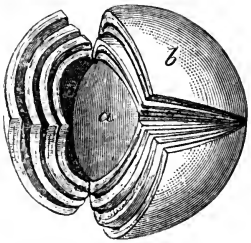


Fig. 294.—A Representation of the Laminæ in a Hardened Lens.

a. The nucleus.
b. Superficial laminæ.

Structure. After the lens has been hardened by spirit or by boiling, it may be demonstrated to consist of a series of layers (fig. 294) arranged one within another, like those of an onion. The laminæ of each surface have their apices in the centre, where the septa meet; they may be detached from one another at that spot, and turned outwards towards the equator of the lens. The laminæ are composed of fine parallel fibres which run between two septa on opposite aspects of the lens.

and fibrous.

Change in form of lens,

Changes in the lens with age. The form of the lens is nearly spherical in the fœtus; but its convexity decreases with age, particularly on the anterior surface, until it becomes flattened in the adult.

in colour and consistence, with age.

In the fœtus it is soft, rather reddish in colour, and not quite transparent; in mature age it is firm and clear; and in old age it becomes flatter on both surfaces, denser, and of a yellowish colour.

CHAPTER XII.

DISSECTION OF THE EAR.

THE organ of hearing is made up of complex bodies, which are lodged in, and attached to the surface of, the temporal bone. It is commonly divided into three parts, known as the external ear, the middle ear, and the internal ear. Of these, the last is the essential portion, containing the terminal expansion of the auditory nerve; and the others are to be regarded as accessory, serving to convey to it the vibrations produced by the sonorous undulations of the air. Subdivision of auditory apparatus.

EXTERNAL EAR. This includes the pinna or auricle and the auditory canal: the former has been noticed at p. 569 *et seq.*, and the latter remains to be described. Parts of outer ear.

The EXTERNAL AUDITORY CANAL (meatus auditorius externus; fig. 295) is the passage which leads from the pinna towards the tympanic cavity (a part of the middle ear), from which it is separated in the recent state by the tympanic membrane. Auditory canal:

Dissection. To obtain a view of this canal, a recent temporal bone is to be taken, to which the cartilaginous pinna remains attached. After the removal of the soft parts, the squamous piece of the bone in front of the Glaserian fissure is to be sawn off; and the front of the meatus, except a ring at the inner end which gives support to the thin membrana tympani, is to be cut away with a pair of bone-forceps. how to obtain a view of i

The *canal* is about one inch and a quarter in length, and is formed partly by bone and partly by cartilage. It is directed forwards somewhat obliquely, and describes a slight vertical curve with the convexity upwards. In shape it is rather flattened from before backwards; and it is narrowest in the osseous portion. The outer extremity is continuous with a hollow (concha) of the external ear, and the inner is closed by the membrana tympani. length; direction; size and shape;

The *cartilaginous part* (*a*) is largest. It is about half an inch in length, and is formed chiefly by the pinna of the outer ear, which is attached to the margin of the osseous meatus; but at the upper and posterior aspect the cartilage is deficient, and the tube is closed by fibrous tissue. One or two fissures (fissures of Santorini) cross the cartilage (p. 571). cartilaginous part is deficient above;

The *osseous part* (*b*) is about three-quarters of an inch long in the adult, and is slightly constricted about the middle. Its outer extremity is dilated, and the posterior edge projects farther than the anterior; the greater portion of the margin is rough, and gives osseous part, outer end

inner end. attachment to the cartilage of the pinna. The inner end is smaller, and is marked in the dry bone, except at the upper part where there is a notch in the osseous margin, by a groove for the insertion of the membrane of the tympanum ; it is so sloped that the anterior wall and the floor extend inwards beyond the hinder wall and the roof for nearly a quarter of an inch.

Condition in the fœtus. In the fœtus the osseous part of the meatus is very imperfect, the floor and anterior wall being composed of fibrous tissue. After birth the osseous wall is completed by an outgrowth from the ring (tympanic bone) which supports the membrana tympani.

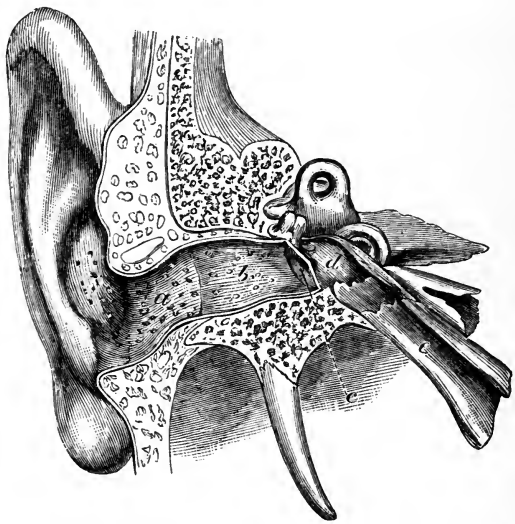


FIG. 295.—VERTICAL SECTION OF THE MEATUS AUDITORIUS AND TYMPANUM (SCARPA).

a. Cartilaginous part of the meatus.
b. Osseous portion.
c. Membrana tympani.
d. Cavity of the tympanum.
e. Eustachian tube.

Lining membrane of the skin. *Lining of the meatus.* A prolongation of the integument lines the auditory passage, and is united more closely to the osseous than to the cartilaginous portion ; it is continued over the membrane of the tympanum in the form of a thin pellicle. At the entrance of the meatus are a few hairs. In the subcutaneous tissue over the cartilage of the meatus lie some ceruminous glands of a yellow-brown colour, resembling in form and arrangement the sweat-glands of the skin ; these secrete the ear-wax, and open on the surface by separate orifices ; they are absent in the osseous part, and are most abundant in that small portion of the tube which is formed by fibrous tissue.

Ceruminous glands.

Vessels. *Vessels and nerves.* The meatus receives its *arteries* from the posterior auricular, the internal maxillary, and the superficial

temporal branches of the external carotid. Its *nerves* are derived from the auriculo-temporal branch of the fifth nerve, and enter the auditory passage between the bone and the cartilage. Nerves.

Middle Ear. The chief part of the middle ear is the tympanum or drum, a cavity containing air, which is interposed between the external auditory canal and the labyrinth or internal ear. The space is traversed by a chain of small bones, with which special muscles and ligaments are connected. It communicates in front with the pharynx by a canal named the Eustachian tube; and behind, it is prolonged into a series of excavations in the mastoid part of the temporal bone—the mastoid cells. Small vessels and nerves ramify in the cavity. Middle ear consists of tympanum, Eustachian tube, and mastoid cells.

Dissection. The tympanic cavity should be examined in both a dried and a recent bone. Dissection

On the dry temporal bone, after removing most of the squamous portion by means of a vertical cut of the saw through the root of the zygoma and the Glaserian fissure, the tympanum will be brought into view by cutting away with the bone-forceps some of the upper surface of the petrous portion, and the anterior part of the meatus auditorius. to open it in the dry bone,

In the recent bone prepare the dissection as above, but without doing injury to the membrana tympani, the chorda tympani nerve, and the chain of bones with its muscles. and in the recent bone.

The TYMPANUM has the form of a very short cylinder, which is placed obliquely, so that its end-surfaces (the inner and outer walls of the tympanum) are nearer to the median plane in front than behind. The circumference of the cylinder is somewhat irregular, and interrupted at parts; in it a roof, a floor, and an anterior and a posterior wall are distinguished. The cavity measures about half an inch from above down and from before back. Its breadth may be given as one-sixth of an inch; but it is wider above and behind than at the lower and fore parts; and it is narrowest in the centre, owing to the projection towards the cavity of the promontory on the inner wall, and of the tympanic membrane externally. Tympanum: form and dimensions.

The *inner boundary* of the tympanum (fig. 296) is formed by the outer wall of the osseous labyrinth, by the parts of which the conformation of this surface is mainly determined. Occupying the greater part of the inner wall is a rounded eminence called the *promontory* (*pr*); this becomes narrow behind, and its surface is marked by two or three minute grooves which lodge the nerves of the tympanic plexus. Above and below the narrowed end of the promontory is an aperture: both lead into the labyrinth. Inner wall is marked by promontory and grooves;

The upper aperture (*fo*) is semicircular in shape, with the convexity upwards, and is named *fenestra ovalis:* it opens into the vestibule, and into it the inner bone (stapes) of the chain is fixed. The lower aperture, *fenestra rotunda* (*fr*), is rather triangular in form, and is situate within a funnel-shaped hollow: in the macerated bone it leads into the cochlea; but in the recent state it is closed by a thin membrane—the secondary membrane of the tympanum. fenestra ovalis; fenestra rotunda;

Arching above the fenestra ovalis on this wall is a ridge of ridge of aqueduct of

Fallopius; and canal of tensor tympani.

bone (*cf**) which marks the situation of the aqueduct of Fallopius, and contains the facial nerve. Lastly, in front of this ridge, and close to the roof of the fore part of the cavity, is the ending of the *canal for the tensor tympani muscle* (*ctt*). The canal is separated from the Eustachian tube (*et*) below it by a thin plate of bone named the *cochleariform process* (*cp*); this becomes expanded on reaching the

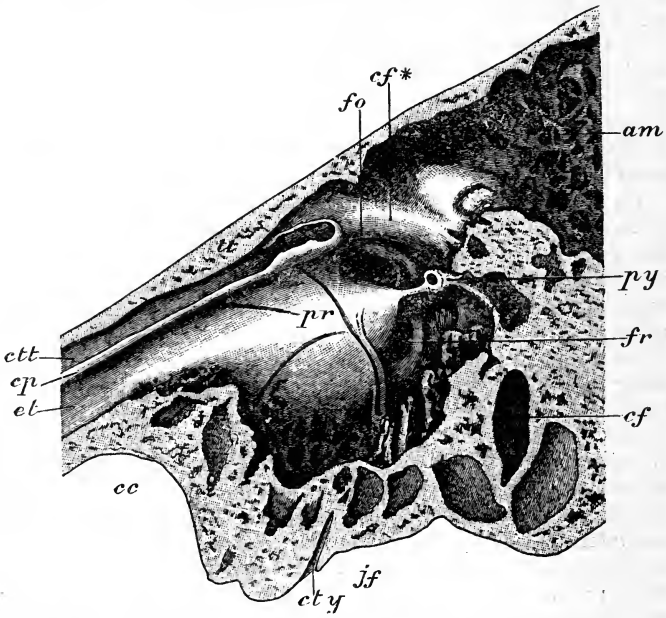


FIG. 296.—INNER WALL OF THE LEFT TYMPANUM: THREE TIMES THE NATURAL SIZE.

pr. Promontory.
fo. Fenestra ovalis.
fr. Fenestra rotunda.
py. Pyramid.
cf. Canal of the facial nerve (aqueduct of Fallopius), cut obliquely.
*cf**. Ridge formed by the canal of the facial nerve.
am. Antrum mastoideum.
tt. Tegmen tympani.
ctt. Canal of the tensor tympani.
cp. Cochleariform process.
et. Eustachian tube.
cc. Carotid canal.
cty. Canal of tympanic nerve.
jf. Jugular fossa.

tympanic cavity, and being bent upwards, prolongs the canal beyond the end of the Eustachian tube. In most cases the outer wall of the tympanic portion of the canal is partly formed by fibrous tissue. The aperture by which the tendon of the muscle escapes is placed a little above and in front of the fenestra ovalis.

On outer boundary, membrana tympani and Glaserian fissure.

The *outer boundary* of the cavity is formed by the membrana tympani (fig. 295, *c*), and the surrounding bone. Above and in front of the membrane is the upper opening of the *Glaserian fissure*, which is occupied in the fresh condition by the long process of one of the small bones (malleus) and some fibres of its anterior ligament,

and by the anterior tympanic vessels. Crossing the membrane towards the upper part is the chorda tympani nerve, which issues through a special aperture close to the Glaserian fissure.

The *roof* (tegmen tympani ; fig. 296, *tt*) is a thin plate of bone separating the tympanic cavity from the cranium. It occasionally presents one or more apertures, where the mucous lining of the tympanum comes into contact with the dura mater. The roof is sometimes perforated.

The *floor* separates the tympanum from the jugular fossa (*j f*), and is more or less excavated by small cells, which are extensions of the tympanic cavity, and lined by a prolongation of its mucous membrane. Floor is cellular.

An *anterior wall* is present only in the lower half of the space, which it separates from the carotid canal (*cc*) ; in the upper half is the tympanic orifice of the Eustachian tube. In front is aperture of Eustachian tube.

The *posterior wall* is similarly deficient in the upper half, where there is a large aperture leading into a space called the *antrum mastoideum* (*am*), from which the mastoid cells are given off. Below this opening, but near the inner wall, and on a level with the narrow part of the promontory, is the small conical projection of the *pyramid* (*py*). At the summit of the pyramid is a small orifice, from which a canal leads backwards and downwards to the aqueduct of Fallopius : the canal lodges the stapedius muscle. Sometimes there is a slender round bar of bone connecting the pyramid to the promontory. Behind are antrum mastoideum and pyramid, with canal of stapedius.

Some objects that have been referred to above, viz., the membrana tympani, the Eustachian tube, the mastoid cells, and the secondary tympanic membrane, require separate notice.

The MEMBRANA TYMPANI (fig. 297) is a thin translucent disc between the external auditory canal and the cavity of the tympanum. It is rather elliptical in shape, and its longest diameter, which is directed from above down, measures about two-fifths of an inch. By its circumference it is attached to a groove at the inner end of the auditory passage. In the fœtus it is supported by a separate osseous ring—the tympanic bone (*f*). The membrane is placed very obliquely, so that it forms an angle of about 45° with both a horizontal and a sagittal plane, the outer surface looking downwards and forwards. It is concave towards the auditory canal, being sloped inwards from the circumference to the centre ; and it projects into the cavity of the tympanum. The handle of the malleus (one of the ossicles ; *b*) is attached to the inner side of the membrane from the centre to the upper margin. Tympanic membrane : form and size ; attachment ; position ; is rather funnel-shaped ; malleus fixed to it.

Structure. The membrane is formed of three strata,—external, internal, and middle. The outer one is continuous with the integuments of the meatus auditorius ; and the inner is derived from the mucous membrane of the tympanum. The middle layer is formed of fibrous tissue, and is fixed to the groove in the bone. From its centre, where it is firmly united to the extremity of the handle of the malleus, fibres radiate towards the circumference ; and near the margin, at the inner aspect, lies a band of stronger circular fibres (fig. 297, *c*), which bridges across the notch at the upper part of the tympanic bone. It consists of a cutaneous, a mucous, and a fibrous layer.

A thin part of the membrane in notch.

Occupying the notch above-mentioned in the upper part of the osseous margin (*notch of Rivinus*), there is a small piece of the membrane which is softer and looser than the rest (*membrana flaccida*), being formed only by lax connective tissue between the skin and the mucous membrane.

Eustachian tube :

The EUSTACHIAN TUBE (fig. 295, *e*) is the channel through which the tympanic cavity communicates with the external air. It is about an inch and a half in length, and is directed forwards and inwards, as well as somewhat downwards, to the pharynx. Like the meatus auditorius, it is partly osseous and partly cartilaginous in texture.

osseous part,

The osseous part is rather more than half an inch in length, and is narrowest at its anterior end. Its course in the temporal bone is

situation

along the angle of union of the squamous and petrous portions, outside the passage for the carotid artery. Anteriorly it

and termination ;

ends in a somewhat oval opening, with an irregular margin, which gives attachment to the cartilage.

cartilaginous part.

The *cartilaginous part* of the tube is nearly an inch in length, and extends from the temporal bone to the interior of the pharynx.

Through this tube the mucous membrane of the drum of the ear is continuous with that of the pharynx ; and through it the mucus escapes.

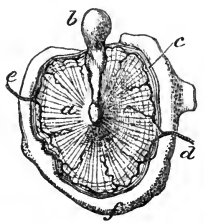


FIG. 297.—INNER VIEW OF THE MEMBRANA TYMPANI IN THE FŒTUS, WITH THE MALLEUS ATTACHED.

a. Membrane of the tympanum.
b. Malleus.
c. Band of circular fibres at the circumference of the membrane.
d. Anterior, and *e*, posterior tympanic artery.
f. Tympanic bone.

Mastoid cells :

The MASTOID CELLS are air-spaces occupying the interior of the temporal bone behind the tympanum and the external auditory meatus.

position and extent ;

They reach downwards into the mastoid process, and upwards for a short distance into the adjoining region of the squamous portion of the bone. In front they communicate with the tympanum through a chamber named the

open into mastoid antrum ;

antrum mastoideum (fig. 296, *am*). Above the tympanic membrane is a small recess communicating with the mastoid antrum, which is called *the mastoid attic*. The size and extent of the cells vary

may approach surface ;

greatly in different individuals ; and in some cases they are separated only by a very thin layer of bone from the exterior of the skull on the one side, and from the lateral sinus on the other. In the infant the mastoid antrum is present, but the cells are not

development.

formed ; the latter are developed at, or a little before, the period of puberty.

Membrane in fenestra rotunda :

The SECONDARY MEMBRANE OF THE TYMPANUM is placed in the fenestra rotunda, and is rather concave towards the tympanum, but convex towards the cochlear passage which it closes.

construction

It is formed of three strata, like the membrane on the opposite side of the cavity, viz., an external or mucous, derived from the

lining of the tympanum; an internal, continuous with that lining the cochlea; and a central layer of fibrous tissue. of three layers.

Ossicles of the Tympanum (figs. 298 and 299, p. 811). Three in number, they are placed in a line across the tympanic cavity. The outer one is named malleus from its resemblance to a mallet; the next, incus, being compared to an anvil; and the last, stapes, from its likeness to a stirrup. For their examination the student should be provided with some separate ossicles. Ossicles of the tympanum are three.

The malleus (fig. 298) is the longest bone, and is twisted and bent. It is large at the upper part (head; *a*) and small and pointed below (handle; *c*); and it has two processes, with a narrowed part or neck. The *head* or capitulum (*a*) is free in the cavity, is club-shaped, and at the back has a depression for articulation with the next bone. The *neck* (*b*) is the constricted part between the head and the processes. The *handle* or manubrium (*c*) Malleus has head, neck, handle,

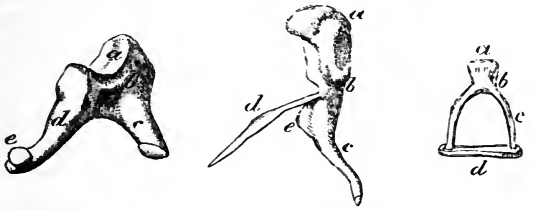


Fig. 298.—The Three Tympanic Ossicles of the Right Side: the Central Bone is the Malleus, the Left-hand one the Incus, and the Right-hand one the Stapes.

Incus:	*Malleus:*	*Stapes:*
a. Articular surface for malleus.	*a.* Head.	*a.* Head.
b. Body.	*b.* Neck.	*b.* Neck.
c. Short process.	*c.* Handle.	*c.* Anterior crus.
d. Long process.	*d.* Long, and	*d.* Base.
e. Orbicular process.	*e.* Short process.	

decreases in size towards the tip, and is compressed from before backwards; but at the extremity it is flattened from within outwards: to its outer margin the special fibrous stratum of the membrana tympani is connected.

The *short process* (*e*) springs from the root of the handle on the outer side, and is attached to the upper border of the tympanic membrane where it bridges across the notch of Rivinus. The *long process* (processus gracilis; *d*) (commonly broken off in removal) is during infancy a slender flattened piece of bone, which projects from the neck of the malleus at the anterior aspect, and extends into the Glaserian fissure; in the adult this process is most frequently converted into a fibrous band; and in cases where the osseous process persists, it is joined with the surrounding bone, and cannot be separated. short and long process.

The incus is a flattened bone (fig. 298), and consists of a body and two processes. The *body* (*b*) is hollowed at the fore part (*a*) to Incus: body;

processes, short and long. articulate with the malleus. The *short process* (*c*) is somewhat conical, and projects backwards nearly horizontally ; its extremity rests against the lower and inner part of the margin bounding the opening into the mastoid antrum. The *long process* (*d*) is almost vertical, and descends parallel to the handle of the malleus, behind and internal to which it lies : it diminishes towards the extremity, where it is bent inwards, and ends in a small flattened knob—the *orbicular process* (*e*), for articulation with the stapes.

Stapes: base; head neck ; and crura. The STAPES (fig. 298) has a base or wider portion, and a head with two sides or crura, like a stirrup. The *base* (*d*) is directed inwards, and is a thin osseous plate, convex at the upper margin and nearly straight at the lower, corresponding with the shape of the fenestra ovalis, into which it is received : the surface turned to the vestibule is convex, while the opposite is excavated. The *head* (*a*) is marked at the extremity by a superficial depression which articulates with the orbicular process of the incus ; and it is supported on a slightly constricted part, the *neck* (*b*). The *crura* extend horizontally from the neck to the base, and are grooved on the surface towards the enclosed aperture ; the anterior crus (*c*) is shorter and straighter than the posterior.

The bones have two sets of ligaments ; either to unite one to another by joints, or to fix them to the tympanic wall. LIGAMENTS OF THE OSSICLES. The small bones of the tympanic cavity are united into one chain by joints, and are farther kept in position by ligaments fixing them to the surrounding wall.

Joints of the bones. Where the ossicles touch, they are connected together by articulations corresponding with the joints of larger bones ; for the osseous surfaces are covered with *cartilage*, are surrounded by a thin *capsular ligament* of fibrous tissue, and lubricated by a *synovial sac*. One articulation of this nature exists between the head of the malleus and the incus, and a second between the orbicular process of the incus and the head of the stapes.

Union of the bones to the wall. The bones are kept in place by the reflection of the mucous membrane over them, and by the following ligaments, three being connected with the malleus, and one each with the incus and stapes :—

Ligaments of malleus are superior, anterior, and external. *Ligaments of the malleus.* The *superior* or *suspensory ligament* is a slender band which descends from the roof of the tympanum to the head of the malleus. The *anterior ligament* is the strongest of all : it passes from the fore part of the neck of the malleus to a projection at the anterior margin of the notch of Rivinus, and to the sides of the Glaserian fissure. A part of this ligament entering the fissure has been described as a muscle under the name of laxator tympani. The *external ligament* is short and fan-shaped : its fibres radiate from the outer and posterior parts of the neck of the malleus to the edge of the notch.

One band to incus, and one to stapes. The *ligament of the incus* attaches the extremity of the short process of that bone to the tympanic wall at the lower part of the orifice of the antrum mastoideum.

The *annular ligament of the stapes* is composed of very short fibres, which unite the circumference of the base of the stirrup to the margin of the fenestra ovalis.

Membrane in aperture of stapes. *Special ligament of the stapes.* Closing the interval between the crura of the stapes there is a very thin membrane which is attached to the groove of the bone. It is covered above and below by the mucous membrane.

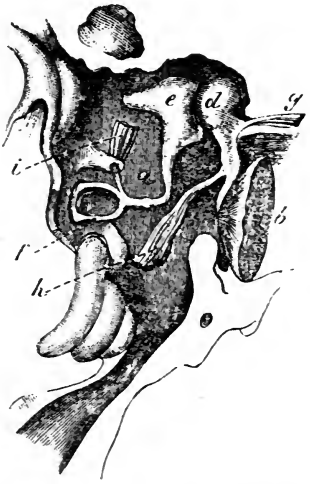
Two muscles to the ossicles. MUSCLES OF THE OSSICLES (fig. 299). Two muscles are connected with the chain of bones, one being attached to the malleus, the other to the stapes.

The TENSOR TYMPANI (fig. 299, *h*) is the larger of the two muscles of the tympanum, and takes the shape of its containing tube, which must be laid open to see it completely. The muscle *arises* in front from the cartilage of the Eustachian tube and the posterior extremity of the great wing of the sphenoid bone, and it also receives fibres from the surface of its bony canal. Posteriorly it ends in a tendon which is reflected over the end of the cochleariform process, and is *inserted* into the inner border of the handle of the malleus near its base.

Tensor tympani: origin; insertion;

Action. The muscle draws inwards the handle of the malleus towards the inner wall of the tympanic cavity, and tightens the membrane of the tympanum; and as the long process of the incus is moved inwards with the malleus, the base of the stapes will be pressed into the fenestra ovalis.

use.



The STAPEDIUS (fig. 299, *i*) is lodged in the canal hollowed in the interior of the pyramid. *Arising* inside the tube, the muscle ends in a small tendon, which issues at the apex of the pyramid, and is *inserted* into the back of the head of the stapes.

Stapedius contained in pyramid;

Action. By directing the neck of the stapes backwards, the muscle raises the fore part of the base out of the fenestra ovalis, diminishing the pressure on the fluid in the vestibule; and supposing it to contract simultaneously with the tensor, it would prevent the sudden jar of the stapes on that fluid.

use.

FIG. 299.—PLAN OF THE OSSICLES OF THE TYMPANUM IN POSITION, WITH THEIR MUSCLES.

a. Cavity of the tympanum.
b. Membrana tympani.
c. Eustachian tube.
d. Malleus.
e. Incus.
f. Stapes.
g. Laxator tympani muscle, sometimes described.
h. Tensor tympani.
i. Stapedius.

MUCOUS MEMBRANE OF THE TYMPANUM. The mucous lining of the tympanic cavity adheres closely to the wall; it is continuous with that of the pharynx through the Eustachian tube, and is prolonged into the mastoid cells through the antrum.

Lining of tympanum:

It forms part of the membrana tympani, and of the secondary membrane in the fenestra rotunda; it is reflected also over the chain of bones, the muscles, ligaments, and chorda tympani nerve. In the tympanum the membrane is thin, not very vascular, and secretes a watery fluid; but in the lower end of the Eustachian tube it is thick and more vascular, and is provided with numerous glands.

arrangement in cavity; in Eustachian tube.

Arteries are branches of carotids.

BLOOD-VESSELS. The *arteries* of the tympanum are furnished from the following branches of the external carotid, viz., internal maxillary, middle meningeal, posterior auricular, and ascending pharyngeal; and some offsets come from the internal carotid in the temporal bone. The *veins* join the pterygoid plexus, and the large meningeal and pharyngeal branches.

From internal maxillary,

The internal maxillary artery supplies an *anterior tympanic branch* (fig. 297, *d*), which enters the cavity through the Glaserian fissure, and gives an offset to the membrane of the tympanum.

middle meningeal,

The middle meningeal artery also sends fine twigs to the upper part of the tympanum through small apertures in the roof of the cavity.

posterior auricular,

The stylo-mastoid branch of the posterior auricular artery, entering the lower end of the aqueduct of Fallopius, gives twigs to the back of the cavity, and the mastoid cells. One of this set, *posterior tympanic* (fig. 297, *e*), anastomoses with the tympanic branch of the internal maxillary artery, and forms a circle around the membrana tympani, from which offsets are directed inwards.

ascending pharyngeal,

Other branches from the ascending pharyngeal, or from the inferior palatine artery, enter the fore part of the space by the Eustachian tube.

internal carotid.

One or two minute branches of the internal carotid artery reach the anterior wall of the tympanum from the carotid canal.

Nerves from several sources.

NERVES. The lining membrane of the tympanum is supplied from the plexus (tympanic) between Jacobson's and the sympathetic nerve; but the muscles derive their nerves from other sources. Crossing the cavity is the chorda tympani branch of the facial nerve.

Dissection to prepare the nerves;

Dissection (fig. 300). The preparation of the tympanic plexus will require a separate fresh temporal bone, which has been softened in diluted hydrochloric acid, and in which the nerves have been hardened afterwards in spirit.

The origin of Jacobson's nerve from the glosso-pharyngeal is first to be sought close to the skull; and the fine auricular branch of the pneumo-gastric may be looked for at the same time (p. 633). Supposing the nerve to be found, the student should place the scalpel on the outer side of the Eustachian tube, and carry it backwards through the vaginal and styloid processes of the temporal bone, so as to take away the outer part of the tympanum, but without opening the lower end of the aqueduct of Fallopius.

outside tympanic cavity,

and inside cavity.

After the tympanum has been laid open, Jacobson's nerve is to be followed in its canal; and the branches in the grooves on the surface of the promontory are to be pursued;—two of these, arching forwards, pass to the sympathetic on the carotid artery and to the Eustachian tube; and two others are directed upwards beneath the tensor tympani muscle.

The course of the chorda tympani nerve can be seen on the preparation used for the muscles.

Tympanic nerve

THE TYMPANIC BRANCH OF THE GLOSSO-PHARYNGEAL NERVE (fig. 300,[2]; nerve of Jacobson) enters a special aperture in the

temporal bone (fig. 296, *cty*), to reach the inner wall of the tympanum. In this cavity the nerve supplies filaments to the lining membrane, to the fenestra rotunda and fenestra ovalis, and to the Eustachian tube; and it terminates in the three under-mentioned branches, which are contained in grooves on the promontory, and connect this nerve with others.

supplies mucous membrane,

and other branches, viz.,

Branches. One branch is arched forwards and downwards, and

one to sympathetic,

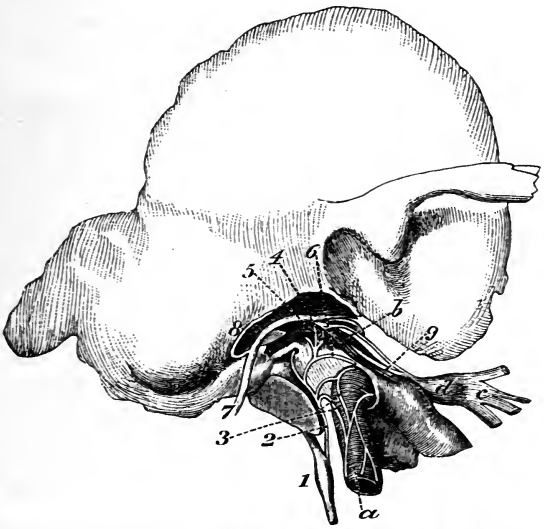


FIG. 300.—JACOBSON'S NERVE IN THE TYMPANUM (BRESCHET).

a. Carotid artery.
b. Tensor tympani muscle.
c. Inferior maxillary trunk of the fifth nerve.
d. Otic ganglion.

Nerves:

1. Petrosal ganglion of the glossopharyngeal.
2. Nerve of Jacobson.
3. Sympathetic on the carotid.
4. Small superficial petrosal nerve.
5. Small deep petrosal nerve.
6. Branch to Eustachian tube.
7. Facial nerve.
8. Chorda tympani.
9. Nerve of the otic ganglion to the tensor tympani muscle.

enters the carotid canal to communicate with the sympathetic (3) on the artery.

The second (5) is the *small deep petrosal nerve*, which is directed forwards through a canal beneath the cochleariform process, to join the carotid plexus of the sympathetic (sometimes also the large superficial petrosal nerve) in the foramen lacerum.

small deep petrosal nerve,

And the third (4) has the following course:—It ascends in front of the fenestra ovalis, and near the gangliform enlargement on the facial nerve, to which it is connected by filaments. Beyond the union with the facial, the nerve is named *small superficial petrosal*, and is continued forwards through the substance of the temporal

and small superficial petrosal

to otic ganglion.

bone, to end in the otic ganglion, and eventually, in great part, to enter the auriculo-temporal nerve and be distributed to the parotid gland.

Nerves for the muscles.

NERVES TO MUSCLES. The tensor tympani muscle is supplied by a branch from the otic ganglion (fig. 300, [9]); and the stapedius receives an offshoot from the facial trunk.

Chorda tympani crosses cavity.

The CHORDA TYMPANI (fig. 300, [8]) is a branch of the facial nerve. Entering the cavity behind, it crosses the membrana tympani, lying on the inner side of the handle of the malleus, and issues from the space by an aperture internal to the Glaserian fissure; it joins the lingual nerve, and its farther course to the tongue is described at p. 688.

Branch of vagus to the outer ear.

The AURICULAR BRANCH OF THE VAGUS, though not a nerve of the tympanum, may now be traced in the softened bone. Arising in the jugular fossa (p. 633), the nerve enters the special canal, and crosses through the substance of the temporal bone to the back of the ear.

INTERNAL EAR OR LABYRINTH.

Labyrinth formed of osseous and membranous parts.

The inner portion of the organ of hearing consists of a complex chamber surrounded by dense bone, within which are included sacs containing fluid, for the terminal expansion of the auditory nerve.

Constituents of the osseous part.

THE OSSEOUS LABYRINTH comprises the vestibule, the semicircular canals, and the cochlea: in the macerated bone these communicate externally with the tympanum, and internally through the meatus auditorius internus with the cranial cavity.

Vestibule;

THE VESTIBULE (fig. 301), or the central cavity of the osseous labyrinth, is placed behind the cochlea, but in front of the semicircular canals.

dissection to see it;

Dissection. This space may be seen on the dry bone which has been used for the preparation of the tympanum. The bone is to be sawn through vertically close to the inner wall of the tympanum, so as to lay bare the fenestra ovalis leading into the vestibule. By enlarging the fenestra ovalis a very little in a direction upwards and forwards, the vestibular space will appear; and the end of the superior semicircular canal will be opened.

Other views of the cavity may be obtained by sections of the temporal bone in different directions, according to the opportunities and skill of the dissector.

form and dimensions;

The *vestibular space* (fig. 301) is ovoidal in form, and the extremities are directed forwards and backwards. The larger end is turned back, and the under-part or floor is more narrowed than the upper part or roof. It measures about one-fifth of an inch in length; but it is narrower from without inwards. The following objects are to be noted on the boundaries of the space.

apertures before and behind;

In front, close to the outer wall, is a large aperture (*g*) leading into the cochlea; and behind are five round openings of the three semicircular canals (*d*, *e*, *f*).

in outer wall;

The outer wall corresponds with the tympanum, and in it is the aperture of the fenestra ovalis. On the inner wall, nearer the front

than the back of the cavity, is a vertical ridge or *crest* (*b*). In front of the crest is a circular depression, *fovea hemispherica* (*a*), which is pierced by minute apertures for nerves and vessels, and corresponds with the bottom of the internal auditory meatus. Behind the crest of bone, near the common opening of two of the semicircular canals, is the aperture of the *aqueduct of the vestibule* (*c*), a narrow canal which ends on the posterior surface of the petrous portion of the temporal bone: it contains a process of the membranous labyrinth called the *ductus endolymphaticus*, and a small vein.

crest on inner wall, with fossa in front,

and aqueduct behind;

The roof is occupied by a slight transversely oval depression,

fossa in roof.

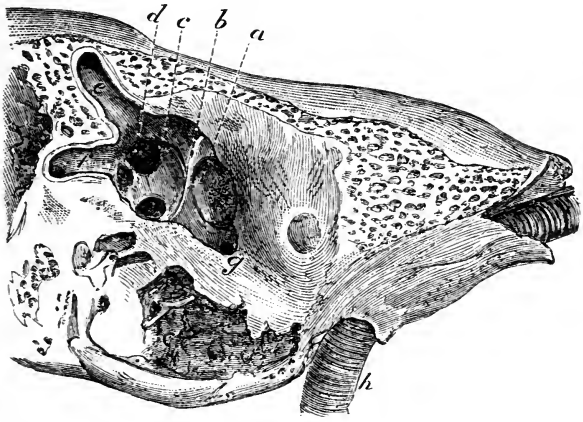


FIG. 301.—VIEW OF THE VESTIBULE OF THE RIGHT SIDE, OBTAINED BY CUTTING AWAY THE OUTER BOUNDARY IN A FŒTUS, ENLARGED THREE TIMES.

a. Fovea hemispherica.
b. Crest of the vestibule.
c. Aperture of aqueduct of the vestibule.
d. Common opening of two semicircular canals.
e. Upper semicircular canal, partly laid open.
f. Horizontal semicircular canal, partly opened.
g. Opening of the scala vestibuli of the cochlea.

fovea hemielliptica; this is separated from the fovea hemispherica by a prolongation of the crest (*b*) on the inner wall.

The SEMICIRCULAR CANALS (fig. 302) are three osseous tubes, which are situate behind the vestibule, and are named from their form.

Three semicircular canals:

Dissection. These small canals will be brought into view by the removal of the surrounding bone by means of a file or bone forceps. Two may be seen opening near the aperture made in the vestibule, and may be followed thence; but the third is altogether towards the posterior aspect of the petrous portion of the temporal bone.

preparation of them;

The *canals* are unequal in length, and each forms more than half an ellipse. They communicate at each end with the vestibule, but

length;

termination by five openings; one end dilated; form and size; they are named

the contiguous ends of two are blended together so as to give only five openings into that cavity. Each is marked by one dilated extremity, called the *ampulla*. When a tube is cut across it is not circular, but is compressed laterally, and measures about $\frac{1}{20}$th of an inch, though in the ampulla the size is as large again.

From a difference in the direction of the tubes, they have been named superior vertical, posterior vertical, and horizontal.

superior vertical,

The *superior vertical canal* (*a*) crosses the upper border of the petrous part of the temporal bone, and forms a projection on the surface. Its outer end is marked by the ampulla, while the inner is joined with the following.

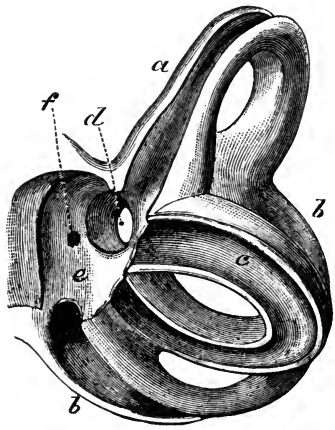


FIG. 302.—REPRESENTATION OF THE SEMICIRCULAR CANALS, ENLARGED.

a. Upper vertical.
b. Posterior vertical, and
c. Horizontal canal.
d. Common opening of the two vertical canals.
e. Part of the vestibular cavity.
f. Opening of the aqueduct of the vestibule.

posterior vertical,

The *posterior vertical canal* (*b*) is directed backwards from its junction with the preceding towards the posterior surface of the temporal bone; it is the longest of all, and has its ampulla at the lower end.

and external or horizontal.

The *horizontal canal* (*c*) has separate apertures, and is the shortest of the three. Deeper in position than the superior vertical, it lies in the substance of the bone nearly on a level with the fenestra ovalis; its dilated end is at the outer side close above that aperture.

Fibrous membrane lines the labyrinth,

Lining membrane of the osseous labyrinth. A thin fibrous periosteal membrane lines the vestibule and the semicircular canals, and is continuous with the fibrous process in the aqueduct of the vestibule. On the outer wall of the cavity it stretches over the fenestra ovalis; and in front it is prolonged into the cochlea through the aperture of the scali vestibuli (fig. 301, *g*). The space between the periosteum and the membranous labyrinth is occupied by a thin fluid—*liquor Cotunnii* or *perilymph*, which also fills the scalæ of the cochlea.

and contains a fluid.

Cochlea:

COCHLEA. This part of the osseous labyrinth has a position anterior to the vestibule, and has received its name from its resemblance to a spiral shell.

dissection for it in dry

Dissection. To obtain a view of the cochlea it will be needful to cut or file away the bone between the promontory of the tympanum and the internal auditory canal on the preparation before used for displaying the vestibule; or this section may be made on another temporal bone in which the semicircular canals are not laid bare.

For the like dissection in the recent state, a softened bone should be used. and recent bone;

The *cochlea* (fig. 303) is conical in form, and is placed almost horizontally in front of the vestibular space. The base of this body is turned to the meatus auditorius internus, and is perforated by small apertures; while the apex is directed to the inner wall of the tympanum, opposite the canal for the tensor muscle. Its length is about a quarter of an inch, and its width at the base is about the same. Resembling a spiral shell, the cochlea consists of a tube wound round a central part or axis; but it differs from the shell in having its tube subdivided by a partition. form and situation; size; resembles a snail-shell in some respects.

The *axis* or *modiolus* (fig. 303, *a*) is the central stem which supports the windings of the spiral tube. Conical in shape, its size Central pillar or axis

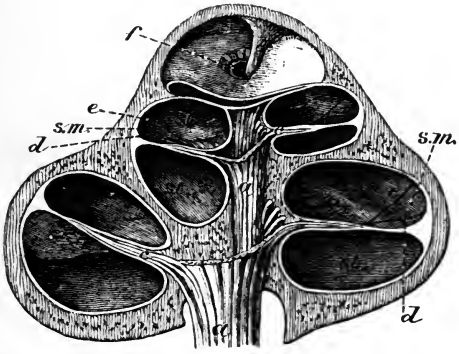


FIG. 303.—SECTION THROUGH THE COCHLEA (BRESCHET).

a. Branches of the auditory nerve, contained in the canals of the axis.
b. Enlarged upper end of the axis.
c. Septum of the cochlea.
e. Membrane of Reissner.
f. Hiatus or helicotrema.
s.t. Scala tympani.
s.v. Scala vestibuli.
s.m. Scala media or canal of the cochlea.

diminishes rapidly towards the last half turn of the tube, but it enlarges at the tip of the cochlea, forming a second small cone (*b*), which is bent. The axis is perforated by canals as far as the contracted part of the last half-turn, and the central one is larger than the others; these transmit vessels and nerves in the fresh state. is conical, and porous.

The *spiral tube* forms two turns and a half round the stem, and terminates above in a closed extremity named the *cupola*. When measured along the outer side, it is about one and a half inch long. Its diameter at the beginning is about one-tenth of an inch, but it diminishes gradually to half that size towards the opposite end. A spiral tube, closed at one end, forms 2½ turns; measurement;

Of the coils that the tube makes, the first is much the largest; this projects towards the tympanum, and gives rise to the eminence of the *promontory* on the inner wall of that cavity. The second turn is included within the first coil. The last half-turn bends sharply round, and presents a free margin (*b*)—the edge of the axis. coils.

Tube divided into two.

In the recent bone the tube is divided into two main passages (scalæ) by the septum (fig. 303). In the dry bone a remnant of this partition is seen in the form of a thin osseous plate—*lamina spiralis*, projecting from the axis.

Septum bony and membranous.

Septum of the spiral tube (fig. 304). The partition in the recent state dividing the tube of the cochlea into two passages, consists of an osseous and a membranous portion :—

Osseous part

The *osseous part* (3), formed by the lamina spiralis, extends about half-way across the tube. Inferiorly it begins in the vestibule,

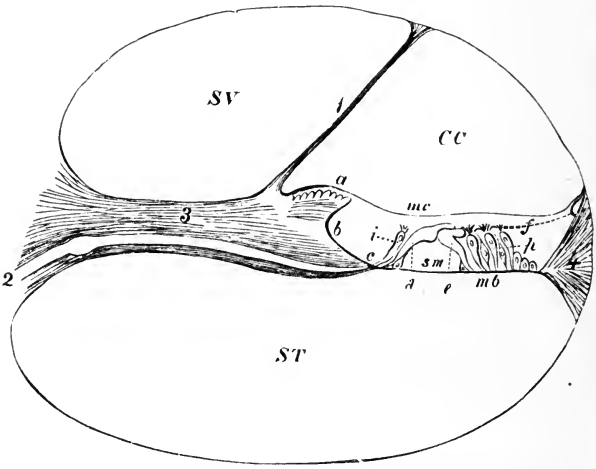


Fig. 304.—A Diagram of a Section of the Tube of the Cochlea, enlarged (modified from Henle).

SV. Scala vestibuli.
ST. Scala tympani.
CC. Canal of the cochlea.
1. Membrane of Reissner.
2. Cochlear branch of the auditory nerve.
3. Lamina spiralis ossea.
4. Ligamentum spirale.
a. Limbus laminæ spiralis.
b. Sulcus spiralis.
c. Tympanic lip of the sulcus spiralis.
mb. Membrana basilaris.
The remaining letters refer to parts of the organ of Corti.

where it is wide, and is attached to the outer wall so as to shut out the fenestra rotunda from that cavity ; and diminishing in size, it ends above in a point—the *hamulus*, opposite the last half-turn of the cochlea. Between the hamulus and the axis is a space, which is converted by the membranous piece of the septum into a foramen (*hiatus, helicotrema ;* fig. 303, *f*), and allows the intercommunication of the two chief passages of the cochlear tube.

ends above in a point

over an aperture.

Lamina spiralis

has limbus on upper surface.

The lamina spiralis is formed by two plates of bone, which enclose canals for vessels and nerves, and are separated farthest from each other at the axis. The upper surface of the lamina is covered in the outer fourth of its extent by a border or *limbus* of

fibrous structure (*a*), which ends in wedge-shaped teeth near the margin of the bony plate.

Between the teeth and the underlying bone is a channel (*b*) which is called *sulcus spiralis:* its edges are named vestibular (*a*) and tympanic (*c*). Spiral groove.

The *membranous part of the septum* (*membrana basilaris;* fig. 304, *m b*) reaches from the lower (tympanic) edge (*c*) of the lamina spiralis to the outer wall of the cochlear tube, where it is fixed by a fibrous band—*ligamentum spirale* (4). Its width varies, for near the base of the cochlea it forms half of the partition across the tube; but at the apex, where the lamina spiralis is wanting, it constructs the septum altogether. Membranous parts includes basilar membrane and spiral ligament.

Scalæ of the cochlear tube:

Scalæ of the cochlea (fig. 303). The tube of the cochlea is divided by the septum into two primary passages, of which one is the *scala tympani* (*s t*), and the other *scala vestibuli* (*s v*); but the latter is rendered smaller by a third canal being cut off from it by membrane.

position; extent; joined above; separate below

The passages are placed one above another, the scala vestibuli (*s v*) being nearest the apex of the cochlea. Above, they communicate through the aperture named helicotrema (*f*). Below, they end differently, as the names express:—the scala vestibuli opens into the front of the vestibule (fig. 301, *g*); but the scala tympani is shut out from the vestibular cavity by the lamina spiralis of the septum cochleæ, and is closed below by the membrane of the fenestra rotunda, though in the dry bone it opens into the tympanum.

they differ in extent and size; opening in lower;

Each has certain peculiarities. The vestibular scala extends into the apex of the cochlea; while the tympanic scala is largest near the base. Connected with the last is the small *aqueduct of the cochlea*, which begins at an opening close to the lower end of the scala, and ends at the lower border of the petrous portion of the temporal bone: it transmits a small vein from the cochlea.

lining membrane, and contents.

The scalæ are clothed with a thin fibrous membrane, continuous with that in the vestibule: in the scala tympani it helps to close the fenestra rotunda, forming the inner layer of the secondary membrane of the tympanum, and joins the fibrous process in the aqueduct of the cochlea. The perilymph fills both scalæ.

Cochlear canal is between basilar membrane and membrane of Reissner; joined by duct from saccule below; contains organ of Corti.

Canal of the cochlea. In the upper division of the cochlear tube a fine membrane (fig. 304, 1) extends obliquely across from the upper surface of the lamina spiralis, at the inner border of the limbus, to the outer wall of the cavity a little above the spiral ligament. This is called the *membrane of Reissner*, and separates a small cavity named the *canal* or *duct of the cochlea* (c c) from the scala vestibuli (s v). The canal thus formed extends from apex to base of the cochlea, and contains a fluid—*endolymph*. Above, it reaches into the cupola and is closed. Below, it is connected by a very small tube (*canalis reuniens;* fig. 305, *c*) with the saccule in the vestibule. Within the canal of the cochlea, resting on the basilar membrane, is the complicated structure known as the *organ of Corti* (fig. 304), in which the cochlear branches of the auditory nerve end.

The membranous labyrinth consists of utricle, saccule, semicircular canals, and cochlear canal.

MEMBRANOUS LABYRINTH (fig. 305). Lodged in the vestibule are two membranous sacs, the utricle and saccule from the former of which tubular offsets are continued into the semicircular canals. These, together with the canal of the cochlea and the organ of Corti, which have been referred to above, make up the membranous labyrinth. The sacs and their prolongations are immersed in the perilymph, and are themselves filled with a fluid called the *endolymph*. In them the ramifications of the auditory nerve are distributed.

Dissection of them in a fresh bone.

Dissection. The delicate internal sacs of the ear, with their nerves, cannot be dissected except on a temporal bone which has been softened in acid, and afterwards put in spirit. The previous instructions for the dissection of the osseous labyrinth will guide the student to the situation of the membranous structures within it, but the surrounding softened material must be removed with great care.

FIG. 305.—PETROUS BONE PARTLY REMOVED TO SHOW THE MEMBRANOUS LABYRINTH OF THE LEFT SIDE IN PLACE (BRESCHET).

a. Saccule.
b. Its macula.
c. Ductus reuniens.
d. Utricle.
e. Its macula.
f. Ampullary enlargement of the external semicircular canal, *g*.

Utricle; situation, and form; macula, and otoliths.

The UTRICLE (fig. 305, *d*), or the *common sinus*, is the larger of the two sacs, and is situate at the posterior and upper part of the vestibule, opposite the fovea hemielliptica in the roof. It is transversely oval in form, and connected with it posteriorly are three looped tubes, which occupy the semicircular canals. At the fore part of the sac is a thickened and more opaque part of its wall—*macula acustica* (*e*), where the nerves enter; and opposite this, in the interior, is a small mass of calcareous granules or *otoliths*.

Semicircular canals: not free in cavity; have ampullæ, which receive the nerves.

The MEMBRANOUS SEMICIRCULAR CANALS (*g*) are about one-third of the diameter of the osseous tubes, along the convex border of which they lie, being closely attached to the periosteal lining of the bony wall; and the remaining space is filled by perilymph. Each is marked at one end by an ampulla, which is relatively of large size and nearly fills the osseous case. Two are blended at one end, like the canals they occupy, so that they communicate with the utricle by five openings. At each ampullary enlargement there is a transverse projection (*crista acustica*) into the anterior of the tube; and at that spot a branch of the auditory nerve enters the wall.

The SACCULE (fig. 305, *a*) is a smaller and rounder cyst than the utricle, in front of which it is placed, in the hollow of the fovea hemispherica. It communicates with the utricle through the ductus endolymphaticus, and is continuous below by a short and small passage (*canalis reuniens; c*) with the canal of the cochlea. Like the other sac, it possesses a macula (*b*) and otoliths where the nerves enter.

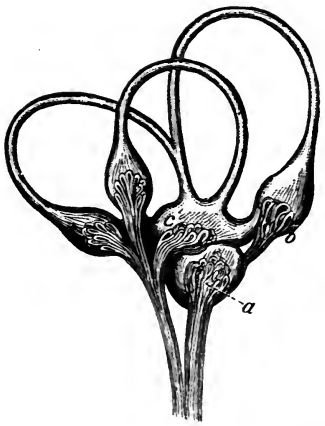
Saccule has communications with utricle and cochlea; macula and otoliths.

The *ductus endolymphaticus* is a fine tubular offset of the membranous labyrinth, which occupies the aqueduct of the vestibule, and ends in a dilated blind extremity (*saccus endolymphaticus*), embedded in the dura mater on the posterior surface of the petrous portion of the temporal bone. In the vestibule the duct divides into two small branches, one of which joins the saccule, and the other the utricle.

Endolymphatic duct and sac; it opens into saccule and utricle.

For an account of the minute structure of the membranous labyrinth, reference must be made to a work on microscopic anatomy.

NERVE OF THE LABYRINTH. A special nerve, the eighth cranial or *auditory*, is distributed to the labyrinth. Entering the internal auditory meatus with the facial nerve, it divides into an upper smaller, and a lower larger piece, each of which again subdivides into three branches. At the bottom of the meatus, the upper piece is marked by a ganglionic swelling—the *intumescentia ganglioformis* of Scarpa.



Auditory nerve divides into two parts; upper has ganglion, and supplies utricle, superior and external canals; lower gives branches to saccule, posterior canal, and cochlea; ending of vestibular branches;

FIG. 306.—DISTRIBUTION OF NERVES TO THE MEMBRANOUS LABYRINTH (BRESCHET).

a. Nerve to the saccule.
b. Nerve entering the ampullary enlargement on the posterior semicircular canal.
c. Nerve entering the utricle. The nerve to the cochlea is not represented.

The *upper division* of the nerve sends its branches to the macula of the utricle (fig. 306, *c*), to the ampulla of the superior vertical semicircular canal, and to the ampulla of the external semicircular canal.

From the *lower division* of the nerve proceed an offset to the saccule (*a*) and a slender branch to the ampulla of the posterior vertical semicircular canal (*b*); but the greater part is destined for the cochlea.

Each of the branches of the auditory nerve breaks up into a bundle of filaments, which pass through minute apertures of the lamina cribrosa, to reach their special part of the membranous labyrinth. The nerves of the semicircular canals enter the ampullæ on their outer flattened side, and end in the crista acustica; while those of the sacs end in the respective maculæ.

cochlear nerve has a spiral ganglion,

The cochlear nerves traverse the canals of the modiolus, and bend outwards in the passages of the lamina spiralis (fig. 304, ²). As they enter the latter, they join a ganglion (*ganglion spirale*) which occupies a winding canal at the junction of the lamina

and ends in organ of Corti.

spiralis with the modiolus; and from this they are continued as fine branches, forming a close plexus, to the organ of Corti.

Vessels of labyrinth.

Blood Vessels. The membranes of the labyrinth are supplied by an artery which enters the internal auditory meatus with the auditory nerve. The veins are more numerous.

Auditory artery from basilar, has a

The internal auditory artery arises from the basilar trunk within the skull, and divides in the internal auditory meatus into two branches,—one for the vestibule, and the other for the cochlea.

vestibular,

The *vestibular artery* subdivides into small offsets which enter the cavity with the branches of the auditory nerve, and ramify over the sacs and the semicircular canals.

and a cochlear branch.

The *cochlear branch* breaks up into numerous fine twigs which enter the modiolus and the canals in the lamina spiralis. Offsets supply the nerve and the parts in the neighbourhood of the limbus laminæ spiralis, and others ramify in the periosteal lining of the scalæ; but there are no vessels in the outer part of the membrana basilaris.

Veins to petrosal sinuses and internal jugular.

Veins. The *internal auditory vein* accompanies the artery, and ends in the inferior petrosal sinus in the base of the skull. The *vein of the aqueduct of the cochlea* joins the internal jugular; and the *vein of the aqueduct of the vestibule* opens into the superior petrosal sinus.

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